Lloyd's Register

Rules and Regulations for the Classification of Ships, July 2006

Notice No. 5

Updated version of Notice No. 5 incorporating Errata Note

Effective Date of Latest Amendments:

See page 1

Issue date: March 2007

RULES AND REGULATIONS FOR THE CLASSIFICATION OF SHIPS, *July 2006*

Notice No. 5

This Notice contains amendments within the following Sections of the *Rules and Regulations for the Classification of Ships, July 2006.* The amendments are effective on the dates shown:

Part	***Chapter***	***Section***	***Effective date***
1	3	20	1 July 2007
Materials	2	1	1 January 2007
Materials	10	1	1 July 2007
3	1	5	1 January 2007
3	1	5	1 July 2007
3	3	5	1 July 2007
3	9	6, 9	1 January 2007
3	10	2	1 July 2007
3	11	9	1 July 2007
3	13	2, 7	1 July 2007
3	13	7	1 January 2007
4	1	9	1 July 2007
4	2	4, 5, 7	1 July 2007
4	2	11	1 January 2007
4	9	1	1 January 2007
5	1	3	1 July 2007
5	2	8, 17, 18	1 July 2007
5	3	3	1 July 2007
5	4	4	1 July 2007
5	6	3	1 July 2007
5	8	5	1 July 2007
5	9	1, 3	1 January 2007
5	10	14	1 July 2007
5	12	2	1 July 2007
5	15	1	1 July 2007
5	15	2	1 January 2007
5	22	1, 2, 3	1 July 2007
6	1	1, 2, 3	1 July 2007
6	2	1, 2, 3, 6, 7, 9, 10, 11, 16, 17, 18	1 July 2007
6	2	13	1 January 2007
6	2	1	Corrigendum
6	3	1, 2, 3, 4, 5, 8, 9	1 July 2007
7	4	2	1 July 2007
7	9	1, 2, 3, 5	1 July 2007
7	11	2, 3	Corrigenda
7	12	1, 2, 3	1 July 2007
7	14	Whole Chapter	1 July 2007

The *Rules and Regulations for the Classification of Ships, July 2006* are to be read in conjunction with this Notice No. 5. The status of the Rules is now:

Rules for Ships	Effective date:	July 2006
Notice No. 1	Effective dates:	1 April, 1 July 2006 & Corrigenda
Notice No. 2	Effective date:	1 January 2007
Notice No. 3	Effective date:	1 July 2006 & Corrigenda
Notice No. 4	Effective date:	1 January 2007 & Corrigenda
Notice No. 5	Effective date:	1 January, 1 July 2007 & Corrigenda

Part 1, Chapter 3
Periodical Survey Regulations

Effective date 1 July 2007

■ *Section 20*
Refrigerated cargo installations

20.2 Special surveys

20.2.10 A General Examination is to be made of all pressure relief valves and/or safety discs throughout the refrigerating plant to ensure that they are in good order and covered by current certification. However, no attempt is to be made to test primary refrigerant pressure relief on board ship. Relief valves are to be removed, overhauled and recalibrated every five years or in accordance with the manufacturer's recommendations, whichever is sooner.

Rules for Materials
Chapter 2
Testing Procedures for Metallic Materials

Effective date 1 January 2007

■ *Section 1*
General requirements for testing

1.1 Preparation of test specimens

1.1.1 The requirements specified below detail all the tests that may be applied to metallic materials. The specific tests and the test specimen types required for each material type, grade and product type are detailed in the subsequent Chapter of these Rules.

~~*1.1.1*~~ *1.1.2* Where test material is cut from products by shearing or flame cutting, a reasonable margin is required to allow sufficient material to be removed from the cut edges during machining of the test specimens.

~~*1.1.2*~~ *1.1.3* Test specimens are to be prepared in such a manner that they are not subjected to any significant work hardening, cold straining or heating during straightening or machining.

~~*1.1.3*~~ *1.1.4* Test samples are not to be removed from the material they represent until heat treatment is complete. For castings in cases where test samples are separately cast, the castings and samples are to be heat treated together.

~~*1.1.4*~~ *1.1.5* Dimensional tolerances are to comply with a relevant ISO specification.

Rules for Materials
Chapter 10
Equipment for Mooring and Anchoring

Effective date 1 July 2007

■ *Section 1*
Anchors

1.7 High holding power (HHP) anchors

1.7.1 Anchor designs for which approval is sought as high holding power anchors are to be tested at sea to show that they have holding powers of at least twice those of approved standard stockless anchors of the same mass.

1.7.2 If approval is sought for a range of sizes, then at least two sizes are to be tested. The smaller of the two anchors is to have a mass not less than one-tenth of that of the larger anchor, and the larger of the two anchors tested is to have a mass not less than one-tenth of that of the largest anchor for which approval is sought.

1.7.3 High holding power anchors are to be of a design that will ensure that the anchors will take effective hold of the sea bed without undue delay and will remain stable, for holding forces up to those required by 1.7.1, irrespective of the angle or position at which they first settle on the sea bed when dropped from a normal type of hawse pipe. In case of doubt, a demonstration of these abilities may be required.

1.7.4 The test should normally be carried out from a tug or other suitable vessel, and the pull measured by dynamometer or derived from recently verified curves of tug rev/min against bollard pull. The tests are to be conducted on not less than three different types of bottom, which should normally be soft mud or silt, sand or gravel, and hard clay or similarly compacted material. A scope of 10 is recommended for the anchor cable, but in no case should a scope of less than 6 be used. The same scope is to be used for the anchor for which approval is sought and the anchor that is being used for comparison purposes.

Existing sub-Sections 1.7 *to* 1.12 *have been renumbered* 1.8 *to* 1.13.

Part 3, Chapter 1
General

Effective date 1 January 2007

■ *Section 5*
Information required

5.2 Plans and supporting calculations

5.2.1 Plans covering the following items are to be submitted:

- Midship sections showing longitudinal and transverse material.
- Profile and decks.
- Shell expansion.
- Oiltight and watertight bulkheads.
- Propeller brackets.
- Double bottom construction.
- Pillars and girders.
- Aft end construction.
- Engine room construction.
- Engine and thrust seatings.
- Fore end construction.
- Hatch coamings.
- Hatch cover construction.
- Deckhouses and superstructures.
- Sternframe.
- Rudder, stock and tiller.
- Equipment.
- Loading Manuals, preliminary and final.
- Ice strengthening.
- Welding.
- Hull penetration plans.
- Support structure for masts, derrick posts or cranes.
- Bilge keels showing material grades, welded connections and detail design.
- Supporting structure of deck fittings used for towing and mooring.

5.2.2 The following supporting documents are to be submitted:

- General arrangement.
- Capacity plan.
- Lines plan or equivalent.
- Dry-docking plan.
- Freeboard plan or equivalent showing freeboards and items relative to the conditions of assignment.
- Towing and mooring arrangements plan as defined in 5.3.8.

Effective date 1 July 2007

- When the ship is required to comply with statutory damage stability criteria:
  Watertight Integrity plan or equivalent showing watertight boundaries and associated design head necessary to satisfy damage stability criteria.

Effective date 1 January 2007

5.3 Plans to be supplied to the ship

5.3.8 The towing and mooring arrangements plan is to be provided on board for the guidance of the Master. The information provided on the plan is to include the following in respect of each shipboard fitting:

- Location on the ship.
- Fitting type.
- Safe working load (SWL).
- Purpose of fitting (mooring/harbour towing/escort towing).
- Manner of applying towing or mooring line load, including limiting fleet angles.

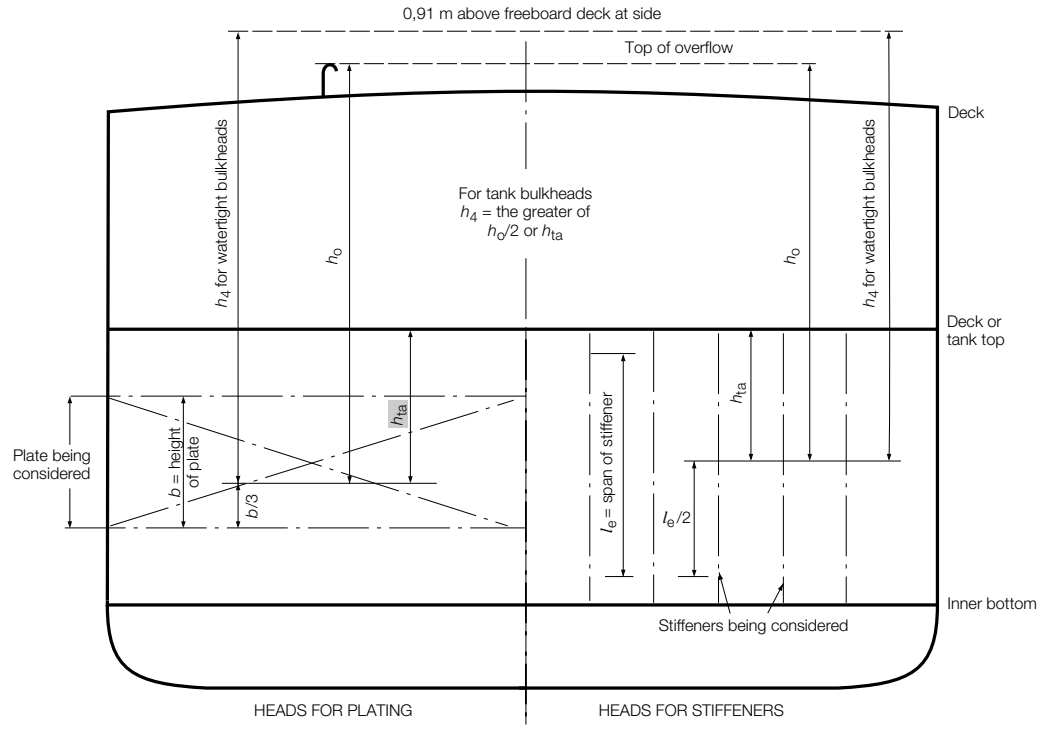
This information is to be incorporated into the pilot card in order to provide the pilot with the necessary information on harbour/escorting operations.

Part 3, Chapter 3
Structural Design

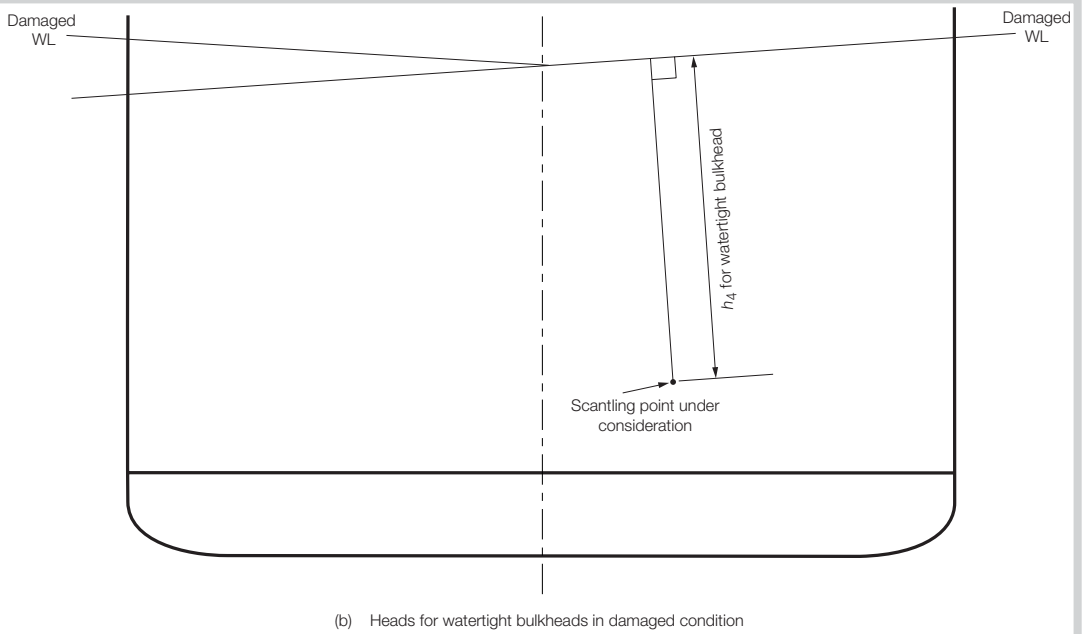
Effective date 1 July 2007

■ *Section 5*
Design loading

5.1 General



(a) Heads for watertight and deep tank bulkheads in intact condition



(b) Heads for watertight bulkheads in damaged condition

Fig. 3.5.2 Heads for watertight and deep tank bulkheads

Part 3, Chapter 9
Special Features

Effective date 1 January 2007

■ *Section 6*
Strengthening requirements for navigation in ice – Application of requirements

6.1 Additional strengthening

6.1.5 The requirements for Ice Class **IE** are for offshore supply ships, as defined in Pt 4, Ch 4, and are intended to navigate in very light first-year ice conditions, such as in brash ice and small ice pieces. The requirements of Section 9 are to be complied with.

~~*6.1.5*~~ *6.1.6* For ships where the ice class notation Ice Class **1AS FS(+)**, Ice Class **1A FS(+)**, Ice Class **1B FS(+)** or Ice Class **1C FS(+)** is requested, the requirements of the Finnish Swedish Ice Class Rules in force at the time of contract, and Section 7, and Pt 5, Ch 9,4 are to be complied with.

~~*6.1.6*~~ *6.1.7* The requirements for strengthening for navigation in ice, as given in Section 8, are intended for ships operating in multi-year ice in Arctic or Antarctic ice conditions under their own power.

■ *Section 9*
Strengthening requirements for navigation in very light first-year ice conditions

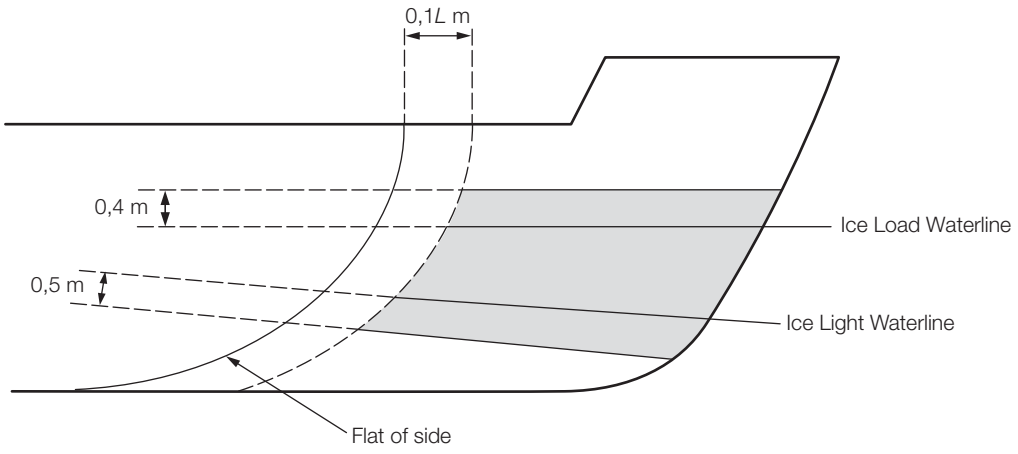
9.1 General

9.1.1 These requirements apply to offshore supply ships, as defined in Pt 4, Ch 4, and which are intended to operate in very light first-year ice conditions. Where additional strengthening is fitted in accordance with the requirements of this sub-Section, the notation Ice Class **1E** will be assigned.

9.1.2 For longitudinally framed ships, the scantlings of shell plating and framing are to comply with the requirements of Ice Class **1C FS** using 0,9 times the ice pressure. The requirements for shell plating need only be applied in the region shown in Fig. 9.1.1. The requirements for framing need only be applied forward of the flat of side.

9.1.3 For transversely framed ships, the requirements of 9.3 to 9.6 are to be applied.

9.1.4 Where the structural requirements of Ice Class **1C FS** give lesser scantlings than the requirements of this sub-Section, the lesser scantlings may be applied.



Ice Load Waterline and Ice Light Waterline are defined in 7.2
L, as defined in Ch 1,6.1

Fig. 9.1.1 Extent of application of plating requirements

9.2 Shell plating

9.2.1 The shell plating thickness within the region shown in Fig. 9.1.1 is not to be less than:

$$t = 21{,}75s\sqrt{k\left(\frac{BL^2}{110000}+1\right)\left(1{,}3-\frac{4{,}2}{(0{,}26/s+1{,}8)^2}\right)} + 2 \text{ mm}$$

where

s = spacing of main frames, in metres

L and B are defined in Ch 1,6.1

k is defined in Ch 2,1.2.

9.3 Transverse framing

9.3.1 The section modulus of main frames forward of the flat of side is not to be less than:

$$z = 6{,}08s\,l\,k\left(\frac{BL^2}{140000}+1{,}23\right)\left(7-\frac{1}{21}\right) \text{ cm}^3$$

but need not be taken as greater than:

$z = sLT$

where

s = spacing of main frames, in metres

l = span, in metres

L and B are defined in Ch 1,6.1

k is defined in Ch 2,1.2.

9.3.2 Intermediate ice frames are to be fitted in the region forward of the flat of side and are to extend from 0,62 m above the Ice Load Waterline to 1 m below the Ice Light Waterline.

9.3.3 Intermediate ice frames aft of the collision bulkhead are to have a section modulus not less than 65 per cent of that given in 9.3.1.

9.3.4 Intermediate ice frames forward of the collision bulkhead are to have a section modulus not less than 40 per cent of that given in 9.3.1.

9.4 Primary longitudinal members supporting ice frames

9.4.1 Forward of the collision bulkhead, in single deck ships, an ice stringer is to be fitted approximately 0,25 m below the Ice Load Waterline and is to have scantlings in accordance with Table 5.4.4 in Chapter 5.

9.4.2 Aft of the collision bulkhead a series of tripping brackets are to be fitted at each main and intermediate frame at the same level as the ice stringer to a distance 0,1L aft of the flat of side.

9.5 Sternframe and rudder

9.5.1 The rudder and sternframe scantlings are to be in accordance with 7.7. However, the ship's speed need not be taken as greater than 14 knots. The hull form factor and the rudder profile coefficients are to be taken as 1,0.

9.6 Weld connections

9.6.1 Weld connections to the shell plating forward of the collision bulkhead are to be double continuous.

Existing Sections 9 *to* 12 *have been renumbered* Sections 10 *to* 13.

Part 3, Chapter 10
Welding and Structural Details

Effective date 1 July 2007

■ *Section 2*
Welding

2.13 Inspection of welds

2.13.7 The method to be used for the volumetric examinations of welds is the responsibility of the Shipbuilder. Radiography using x-rays is generally preferred for the examination of butt welds of ~~15 mm~~ 10 mm thickness or less. Ultrasonic ~~testing~~ examination is acceptable for welds of ~~15 mm~~ 10 mm thickness or greater and is to be used for the examination of full ~~penetration tee~~ penetration, tee butt or cruciform welds or joints of similar configuration. Where ultrasonic inspection of welds below 10 mm in thickness is proposed, this will be specially considered by LR NDE.

2.13.8 Non-destructive examinations are to be made in accordance with ~~approved~~ definitive written procedures prepared ~~by the Shipbuilder, which identify the method and technique to be used, the extent of the examination and the acceptance criteria to be applied.~~ in accordance with a nationally or internationally recognised standard and authorised by Level III qualified personnel. As a minimum, procedures are to identify personnel qualification levels required, NDE datum and identification system, the extent of testing, NDE methods to be applied with technique sheets, acceptance criteria to be applied and the reporting requirements. All NDE procedures are to be approved by a surveyor prior to beginning examination.

2.13.9 Non-destructive examinations are to be undertaken by personnel qualified to ~~the~~ an appropriate level of a certification scheme recognised by LR, such as those based on the requirements of ISO 9712, EN 473 or SNT-TC-1A. Generally, inspection personnel subject to direct supervision are to be qualified to Level I; where personnel are unsupervised, they are required to be qualified to Level II or Level III as appropriate. Qualification schemes for Level I and II personnel are to include assessment of practical ability where examinations are to be made on representative test pieces containing relevant defects. The results of qualification tests are to be made available upon request.

Part 3, Chapter 11
Closing Arrangements for Shell, Deck and Bulkheads

Effective date 1 July 2007

■ *Section 9*
Watertight doors in bulkheads below the freeboard deck

9.2 Watertight doors

9.2.1 Watertight doors are to be of equivalent strength to the unpierced bulkhead, efficiently constructed and fitted, and are to be capable of being ~~operated~~ closed watertight when the ship is listed up to 15° either way. They are to be operated under working conditions and hose tested in place, *see* Ch 1,8.3.

Part 3, Chapter 13
Ship Control Systems

Effective date 1 July 2007

■ *Section 2*
Rudders

2.4 Rudder stock and main bearing

Table 13.2.6 Bearing requirements for rudder stock and pintles (*Part only shown*)

(2) Bearing length	~~$1{,}0\delta \le l_B \le 1{,}2\delta$ mm~~ The length/diameter ratio of the actual bearing surface is not to be greater than 1,2

Effective date 1 July 2007

■ *Section 7* Equipment

7.3 High holding power anchors

~~*7.3.1* Anchors of designs for which approval is sought as high holding power anchors are to be tested at sea to show that they have holding powers of at least twice those of approved standard stockless anchors of the same mass.~~

~~*7.3.2* If approval is sought for a range of sizes, then at least two sizes are to be tested. The smaller of the two anchors is to have a mass not less than one-tenth of that of the larger anchor, and the larger of the two anchors tested is to have a mass not less than one-tenth of that of the largest anchor for which approval is sought.~~

~~*7.3.3* The tests are to be conducted on not less than three different types of bottom, which should normally be soft mud or silt, sand or gravel, and hard clay or similarly compacted material.~~

~~*7.3.4* The test should normally be carried out from a tug, and the pull measured by dynamometer or derived from recently verified curves of tug rev/min against bollard pull. A scope of 10 is recommended for the anchor cable, which may be wire rope for this test, but in no case should a scope of less than 6 be used. The same scope is to be used for the anchor for which approval is sought and the anchor that is being used for comparison purposes.~~

~~*7.3.5* High holding power anchors are to be of a design that will ensure that the anchors will take effective hold of the sea bed without undue delay and will remain stable, for holding forces up to those required by 7.3.1, irrespective of the angle or position at which they first settle on the sea bed when dropped from a normal type of hawse pipe. In case of doubt, a demonstration of these abilities may be required.~~

~~*7.3.6*~~ *7.3.1* When high holding power anchors are used as bower anchors, the mass of each such anchor may be 75 per cent of the mass given in the Table for ordinary stockless bower anchors.

Effective date 1 January 2007

7.5 Towlines and mooring lines

7.5.6 ~~Means are to be provided to enable mooring lines to be adequately secured on board ship. It is recommended that the total number of suitably placed bollards on either side of the ship and/or the total rake holding power of mooring winches should be capable of holding not less than 1,5 times the sum of the maximum breaking strengths of the mooring lines required or recommended. Attention is drawn to the existence of a number of National Standards for bollards and fairleads, and to the importance of ensuring that their seating arrangements, including the supporting hull structure, are efficiently constructed and adequate for the intended loads.~~ Mooring winches should be fitted with drum brakes, the strength of which is sufficient to prevent unreeling of the mooring line when the rope tension is equal to 80 per cent of the breaking strength of the rope as fitted on the first layer on the winch drum.

Effective date 1 July 2007

7.7 Testing of equipment

7.7.4 For holding power testing requirements relating to high holding power anchors, *see* Pt 2, Ch 10,1.7.

Effective date 1 January 2007

7.8 Structural requirements associated with anchoring

7.8.6 Chain lockers and spurling pipes are to be watertight up to the exposed weather deck and the space is to be efficiently drained. However, bulkheads between separate chain lockers, or which form a common boundary of chain lockers, need not be watertight.

7.10 Structural requirements associated with towing and mooring

7.10.1 The following requirements are applicable to bollards and bitts, fairleads, stand rollers and chocks used for the normal mooring and towing of the vessel, the supporting structure and their attachment to it. They are also applicable to the supporting structure of capstans, winches and similar items used for the normal mooring and towing of the vessel. Any weld, bolt or equivalent device connecting the shipboard fitting to the supporting structure is part of the shipboard fitting and is subject to the National or International standard applicable to that shipboard fitting.

7.10.2 The design criteria in this sub-Section are to be used to derive the net scantlings of the supporting structure. A corrosion addition of 2 mm is to be added to the net thickness derived.

Effective date 1 January 2007

Table 13.7.3 Equipment – Stream anchors, stream wires, towlines and mooring lines (*Part only shown*)

Equipment number		Equip-ment Letter	Mass of stock-less stream anchor, in kg	Stream wire or chain		Towline[1]		Mooring lines		
Exceeding	Not exceeding			Minimum length in metres	Minimum breaking strength, in kN	Minimum length in metres	Minimum breaking strength, in kN	Number	Minimum length of each line, in metres	Minimum breaking strength, in kN
50	70	A	60	80	64,7	180	98	3	80	34
70	90	B	80	85	73,5	180	98	3	100	37
90	110	C	100	85	81,4	180	98	3	110	39
110	130	D	120	90	89,2	180	98	3	110	44
130	150	E	140	90	98,1	180	98	3	120	49
150	175	F	165	90	107,9	180	98	3	120	54
175	205	G	190	90	117,7	180	112	3	120	59
205	240	H	—	—	—	180	129	4	120	64
240	280	I	—	—	—	180	150	4	120	69
280	320	J	—	—	—	180	174	4	140	74
320	360	K	—	—	—	180	207	4	140	78
360	400	L	—	—	—	180	224	4	140	88
400	450	M	—	—	—	180	250	4	140	98
450	500	N	—	—	—	180	277	4	140	108
500	550	O	—	—	—	190	306	4	160	123
550	600	P	—	—	—	190	338	4	160	132
600	660	Q	—	—	—	190	370	4	160	147
660	720	R	—	—	—	190	406	4	160	157
720	780	S	—	—	—	190	441	4	170	172
780	840	T	—	—	—	190	479	4	170	186
840	910	U	—	—	—	190	518	4	170	201
910	980	V	—	—	—	190	559	4	170	216
980	1060	W	—	—	—	200	603	4	180	230
1060	1140	X	—	—	—	200	647	4	180	250
1140	1220	Y	—	—	—	200	691	4	180	270
1220	1300	Z	—	—	—	200	738	4	180	284
1300	1390	A†	—	—	—	200	786	4	180	309
1390	1480	B†	—	—	—	200	836	4	180	324
1480	1570	C†	—	—	—	220	888	5	190	324
1570	1670	D†	—	—	—	220	941	5	190	333
1670	1790	E†	—	—	—	220	1024	5	190	353
1790	1930	F†	—	—	—	220	1109	5	190	378
1930	2080	G†	—	—	—	220	1168	5	190	402
2080	2230	H†	—	—	—	240	1259	5	200	422
2230	2380	I†	—	—	—	240	1356	5	200	451
2380	2530	J†	—	—	—	240	1453	5	200	480
2530	2700	K†	—	—	—	260	1471	6	200	480
2700	2870	L†	—	—	—	260	1471	6	200	490
2870	3040	M†	—	—	—	260	1471	6	200	500
3040	3210	N†	—	—	—	280	1471	6	200	520
3210	3400	O†	—	—	—	280	1471	6	200	554
3400	3600	P†	—	—	—	280	1471	6	200	588
3600	3800	Q†	—	—	—	300	1471	6	200	618
3800	4000	R†	—	—	—	300	1471	6	200	647
4000	4200	S†	—	—	—	300	1471	7	200	647
4200	4400	T†	—	—	—	300	1471	7	200	657
4400	4600	U†	—	—	—	300	1471	7	200	667
4600	4800	V†	—	—	—	300	1471	7	200	677
4800	5000	W†	—	—	—	300	1471	7	200	686
5000	5200	X†	—	—	—	300	1471	8	200	686
5200	5500	Y†	—	—	—	300	1471	8	200	696
5500	5800	Z†	—	—	—	300	1471	8	200	706
5800	6100	A*	—	—	—	300	1471	9	200	706
6100	6500	B*	—	—	—	—	—	9	200	716
6500	6900	C*	—	—	—	—	—	9	200	726
6900	7400	D*	—	—	—	—	—	10	200	726
7400	7900	E*	—	—	—	—	—	11	200	726
7900	8400	F*	—	—	—	—	—	11	200	736
8400	8900	G*	—	—	—	—	—	12	200	736
8900	9400	H*	—	—	—	—	—	13	200	736
9400	10000	I*	—	—	—	—	—	14	200	736
10000	10700	J*	—	—	—	—	—	15	200	736
10700	11500	K*	—	—	—	—	—	16	200	736
11500	12400	L*	—	—	—	—	—	17	200	736
12400	13400	M*	—	—	—	—	—	18	200	736
13400	14600	N*	—	—	—	—	—	19	200	736
14600	16000	O*	—	—	—	—	—	21	200	736

7.10.3 Shipboard fittings for towing or mooring are to be located on longitudinals, beams and/or girders, which are part of the deck construction so as to facilitate efficient distribution of the load. Other arrangements will be specially considered provided that the strength is confirmed as adequate for the service.

7.10.4 The design load applied to shipboard fittings and supporting hull structure is not to be less than that given in Table 13.7.8.

Table 13.7.8 Minimum design load for deck fittings and supporting structure

Use/Item	Minimum design load(1)
Normal towing (harbour/manoeuvring)	1,25 times the intended maximum towing load as indicated on the towing and mooring arrangements plan
Escort towing	minimum breaking strength of the towline given in Table 13.7.3 for the ship's corresponding mooring equipment number(2)
Mooring	1,25 times the breaking strength of the mooring line given in Table 13.7.3 for the ship's corresponding mooring equipment number(2)
Winches, etc.	1,25 times the intended maximum brake holding power
Capstans	1,25 times the maximum hauling in force

NOTES
1. If a greater design load is specified by the designer this load is to be used.
2. The mooring equipment number is to be calculated as shown in 7.10.11 to 7.10.14.

7.10.5 The design load is to be applied according to the arrangement shown on the towing and mooring arrangement plan. The point of action of the force on the fitting is to be taken as the point of attachment of the mooring line or towline or at a change in its direction. The total design load applied to a fitting need not be more than twice the design load, *see* Fig. 13.7.3.

7.10.6 The selection of shipboard fittings is to be made by the shipyard in accordance with an acceptable National or International standard (e.g. ISO3913 Shipbuilding Welded Steel Bollards). If the shipboard fitting is not selected from an acceptable National or International standard then the design load used to assess its strength and its attachment to the ship is to be in accordance with the design load given in Table 13.7.8 and the design is to be submitted for approval.

7.10.7 The reinforced members beneath shipboard fittings are to be effectively arranged for any variation of the direction, in both the lateral and vertical plane, of the forces acting through the arrangement.

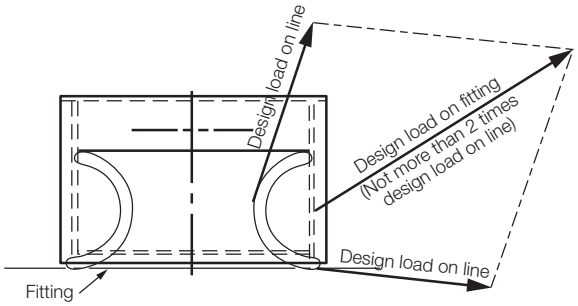


Fig. 13.7.3 Design load applied to fittings

7.10.8 The stress within the supporting structure of fittings is not to exceed that given in Table 13.7.9.

Table 13.7.9 Allowable stress within the supporting structure of shipboard fittings

	Normal stress, in N/mm^2	Shear stress, in N/mm^2
Allowable stress	$\frac{235}{k}$	$\frac{141}{k}$

where

$k = \frac{235}{\sigma_0}$

σ_0 = specified minimum yield strength of the material in N/mm^2

7.10.9 The Safe Working Load (SWL) of a shipboard fitting used for normal towing and mooring is not to be greater than 80 per cent of the design load. The SWL of a shipboard fitting used for escort towing is not to be greater than the design load. For fittings used for both operations, the greater design load is to be used.

7.10.10 The SWL of each shipboard fitting is to be marked, by weld bead or equivalent, on the fitting and relates to a single post basis.

7.10.11 When determining the minimum design load for deck fittings and supporting structure the 'Mooring Equipment Number' is to be calculated as follows:

$$\text{Mooring Equipment Number} = \Delta^{2/3} + 2BH + \frac{A}{10}$$

where

A = area, in m^2, in profile view of the hull including the projected area of all deck cargo, within the Rule length of the vessel, and of superstructures and houses above the summer load waterline, which are within the Rule length of the vessel, and also having a breadth greater than $\frac{B}{4}$

See also 7.10.12 and 7.10.13

B = greatest moulded breadth, in metres

H = freeboard amidships, in metres, from the summer load waterline to the upper deck, plus the sum of the heights at the centreline, in metres, of each tier of houses having a breadth greater than $\frac{B}{4}$

See also 7.10.12, 7.10.13 and 7.10.14

Δ = moulded displacement, in tonnes, to the summer load waterline.

7.10.12 In the calculation of H and A, sheer and trim are to be ignored. Where there is a local discontinuity in the upper deck, H is to be measured from a notional deckline.

7.10.13 If a house having a breadth greater than $\frac{B}{4}$ is above a house with a breadth of $\frac{B}{4}$ or less, then the wide house is to be included, but the narrow house ignored.

7.10.14 Screens and bulwarks more than 1,5 m in height are to be regarded as parts of houses when determining H and A. Where a screen or bulwark is of varying height, the portion to be included is to be that length, the height of which exceeds 1,5 m.

Part 4, Chapter 1
General Cargo Ships

Effective date 1 July 2007

■ *Section 9*
Bulkheads

9.2 Watertight and deep tank bulkheads

Table 1.9.1 Watertight and deep tank bulkhead scantlings *(Part only shown)*

Symbols
h_4 = load head, in metres measured ~~vertically~~ as follows: (a) For watertight bulkhead plating, the distance vertically from a point one-third of the height of the plate above its lower edge to a point 0,91 m above the bulkhead deck at side or perpendicular to the deepest equilibrium waterline in damaged condition obtained from applicable damage stability calculations, whichever is the greater, *see also* Fig. 3.5.2 in Pt 3, Ch 3 (b) For deep tank bulkhead plating, the distance from a point one-third of the height of the plate above its lower edge to the top of the tank, or half the distance to the top of the overflow, whichever is the greater, *see also* Fig. 3.5.2 in Pt 3, Ch 3 (c) For watertight bulkhead stiffeners or girders, the distance vertically from the middle of the effective length to a point 0,91 m above the bulkhead deck at side, or perpendicular to the deepest equilibrium waterline in damaged condition obtained from applicable damage stability calculations, whichever is the greater, *see also* Fig. 3.5.2 in Pt 3, Ch 3 (d) For deep tank bulkhead stiffeners or girders, the distance from the middle of the effective length to the top of the tank, or half the distance to the top of the overflow, whichever is the greater, *see also* Fig. 3.5.2 in Pt 3, Ch 3

Part 4, Chapter 2
Ferries, Roll-on-Roll off Ships and Passenger Ships

Effective date 1 July 2007

■ *Section 4*
Shell envelope plating

4.2 Bow flare and wave impact pressures

4.2.2 Alternatively, P_{bf} may be derived by the direct calculations carried out in accordance with a procedure agreed by LR.

■ *Section 5*
Shell envelope framing

5.2 Strengthening for wave impact loads

(*Part only shown*)

5.2.2 The scantlings of secondary stiffeners are not to be less than:

(a) ~~Section modulus of secondary stiffeners~~ Effective plastic section modulus of stiffeners:

$$Z = \frac{h_s\, s_{cm}\, k\, l_e^2}{483} \text{ cm}^3$$

$$Z_p = 3{,}75 h_s\, s_{cm}\, k\, l_e^2 \times 10^{-3} \text{ cm}^3$$

where

h_s = wave impact head, in metres, as defined in 4.3.2

s_{cm} = mean spacing of secondary stiffeners, in mm, measured along a chord between parallel adjacent members or equivalent supports, as shown in Fig. 2.4.2

5.2.3 The effective section properties of secondary stiffeners are to be taken as:

(a) Plastic section modulus of secondary stiffeners, Z_p, is to be taken as:

$$Z_p = 2{,}8 \times 10^{-4}\, s_{cm}\, t_p^2 - 10^{-3}\, b_f\, b_{fc}\, t_f \sin\theta_e + 5 \times 10^{-4} (h_w^2\, t_w + 2 b_f\, t_f\, h_w) \cos\theta_e \text{ cm}^3$$

where

θ_e = $C_0 (90 - \varphi)$

C_o = 1,1

φ = the angle between the stiffener and the side shell, in degrees

b_{fc} = 0,5 $(b_f - t_w)$ for L profiles
= 0 for flat bar and T profiles
= *see* Fig. 4.7.1 in Pt 3, Ch 4, for bulb profiles

h_w = height of stiffener, in mm

t_w = web thickness, in mm

b_f = breadth of flange, in mm

t_f = flange thickness, in mm

t_p = thickness of attached plating, in mm

(b) Web area of secondary stiffeners, A_s, is to be taken as:

$$A_s = 0{,}01 (h_w + t_p)\, t_w \sin\varphi \text{ cm}^2$$

5.2.4 Where the stiffener web is not perpendicular to the plating, tripping brackets have to be fitted in order to obtain adequate lateral stability.

Existing paragraphs 5.2.3 *to* 5.2.5 *have been renumbered* 5.2.5 *to* 5.2.7.

(*Part only shown*)

~~*5.2.3*~~ *5.2.5* The scantlings of primary members are not to be less than:

(c) The web of the primary member is to be adequately stiffened.

~~*5.2.7*~~ *5.2.8* ~~Where the stiffener web is not perpendicular to the plating, tripping brackets may need to be fitted in order to obtain adequate lateral stability. For stiffeners and primary structure where~~ Where the angle between ~~stiffener~~ primary structure web and the plating is less than 70°, the effective section modulus and shear area are to take account of the non-perpendicularity.

Existing paragraphs 5.2.6 *and* 5.2.8 *have been renumbered* 5.2.9 *and* 5.2.10.

Effective date 1 July 2007

■ *Section 7*
Peak, watertight and deep tank bulkheads

7.1 General

7.1.2 The load head, h_4 to be used in watertight bulkhead scantlings for passenger ships is, in addition, to comply with the following:

- For watertight bulkhead plating, the distance from a point one-third of the height of the plate above its lower edge to a point 0,91 m above the bulkhead deck at side, or to the deepest intermediate/equilibrium waterline in damaged condition obtained from applicable damage stability calculations, whichever is the greater.
- For watertight bulkhead stiffeners or girders, the distance from the middle of the effective length to a point 0,91 m above the bulkhead deck at side, or to the deepest intermediate/equilibrium waterline in damaged condition obtained from applicable damage stability calculations, whichever is the greater.

7.1.3 Partial watertight bulkheads and webs fitted above the bulkhead deck which are to be included in damage stability calculations, are to be assessed as watertight, *see* 7.1.2.

Effective date 1 January 2007

■ *Section 11*
Miscellaneous openings

11.3 Strength assessment of windows in ~~large~~ passenger ships

11.3.2 For passenger ships ~~with a length greater than 150m~~ the design pressure, H_d, on windows is to be taken as given in Table 2.11.2, or an equivalent National or Internationally recognized standard.

Table 2.11.2 Design pressure, H_d, on window
(*Part only shown*)

Symbols
$Z_{1,5}$ = the vertical location, in metres, above the waterline at which the BS MA:25 ~~calculated~~ pressure as given in Annex E of BS MA:25 (1973) is 1,5 t/m^2

Part 4, Chapter 9
Double Hull Oil Tankers

Effective date 1 January 2007

■ *Section 1*
General

1.2 Application and ship arrangement

1.2.21 Where DWT ≥ 5000 tonnes, the cargo pump room shall be provided with a double bottom such that at any cross-section the depth of each double bottom tank or space shall be such that the distance d_c, as defined in 1.5, is not less than the lesser of $\frac{B}{15}$ m and 2 m.

d_c is in no case to be less than 1 m.

In the case of cargo pump rooms whose bottom plate is located above the base line by at least the minimum height required, there will be no need for a double bottom construction in way of the cargo pump-room.

1.2.22 Notwithstanding the requirements of 1.2.21, above, where the flooding of the cargo pump-room would not render the ballast or cargo pumping system inoperative, a double bottom need not be fitted.

1.5 General definitions and symbols

(Part only shown)

1.5.1 The following symbols and definitions are applicable to this Chapter unless otherwise stated:

L, L_L, *B*, *D*, *T* as defined in Pt 3, Ch 1,6.

d_c = the height between the ship's base line and the bottom of the cargo pump room, in metres

Part 5, Chapter 1
General Requirements for the Design and Construction of Machinery

Effective date 1 July 2007

■ *Section 3*
Operating conditions

3.4 Definitions

3.4.1 Main propulsion engines and turbines are defined as those which drive main propelling machinery directly or indirectly through mechanical shafting and which may also drive electrical generators to provide power for auxiliary services. Auxiliary engines and turbines are defined as those coupled to electrical generators which provide power for auxiliary services, for electrical main propulsion motors or a combination of both.

~~*3.4.1*~~ *3.4.2* Units and formulae included in the Rules are shown in SI units followed by metric units in brackets, where appropriate.

~~*3.4.2*~~ *3.4.3* Where the metric version of shaft power, i.e. (shp), appears in the Rules, 1 shp is equivalent to 75 kgf m/s or 0,735 kW.

~~*3.4.3*~~ *3.4.4* Pressure gauges may be calibrated in bar, where:

1 bar = 0,1 N/mm^2 = 1,02 kgf/cm^2.

3.10 Machinery interlocks

3.10.1 Interlocks are to be provided to prevent any operation of engines or turbines under conditions that could hazard the machinery and personnel. These are to include 'turning gear engaged', 'low lubricating oil pressure', where oil pressure is essential for the prevention of damage during start up, 'shaft brake engaged' and where machinery is not available due to maintenance or repairs. The interlock system is to be arranged to be 'fail safe'.

3.10.2 Where machinery is provided with manual turning gear, warning devices or notices may be provided as an alternative to interlocks as required by 3.10.1.

Part 5, Chapter 2
Oil Engines

Effective date 1 July 2007

■ *Section 8*
Starting arrangements and air compressors

8.1 Initial starting arrangements

8.1.5 For cargo ships of less than 500 gross tons and which are not required to comply with the *International Convention for the Safety of Life at Sea, 1974*, as amended (SOLAS 74), alternative arrangements to those specified in 8.1.3 or 8.1.4 may be proposed for consideration. Details of the alternative arrangements are to be included in the plans and details required by 1.1.6 and are to demonstrate that the arrangements provide for starting from the dead ship condition and are in accordance with any applicable statutory requirements of the National Authority of the country in which the ship is to be registered.

8.4 Electric starting

8.*4.6* For cargo ships of less than 500 gross tons which are not required to comply with the *International Convention for the Safety of Life at Sea, 1974*, as amended (SOLAS 74), the emergency source of electrical power may be used as one of the sources of energy required by 8.4.1 or 8.4.2 for electric starting. Where the emergency source of electrical power is an accumulator battery and it is to be used for electric starting, it is to have the additional capacity required to ensure emergency supplies are not compromised and is to be adequately protected and suitably located for use in an emergency.

■ *Section 17*
General requirements

17.1 Turning Gear

17.1.1 Turning gear is to be provided for all engines to facilitate operating and maintenance regimes as required by the manufacturer.

17.1.2 The turning gear for all main propulsion engines is to be power-driven and, if electric, is to be continuously rated at a value to ensure protection to the weakest part of the machinery.

17.1.3 The turning gear for auxiliary engines may be hand operated (manual) except where this is not practicable, in which case the provision of 17.1.2 is to be complied with.

17.1.4 The turning gear for all engines is to be fitted with safety interlocks which prevent engine operation when engaged, *see* Ch 1,3.10. Indication of engaged/not engaged is to be provided at all start positions.

17.1.5 The remote control device of power-driven turning gear is to be so designed that power is removed from the turning gear when the operating switch is released.

17.1.6 Means are to be provided to secure the turning gear when disengaged.

17.1.7 Overload protection arrangements are to be provided to prevent damage to the electric motor and the turning gear train.

■ *Section 18*
Program for trials of diesel engines to assess operational capability

18.1 Works trials (acceptance test)

18.1.1 Diesel engines which are to be subjected to trials on the test bed at the manufacturer's works and under attendance by the Surveyor(s) are to be tested in accordance with the scope of works trials specified in 18.1.2 to 18.1.9. The scope of the trials is to be agreed between the LR Surveyor and the manufacturer prior to testing. At the discretion of the Surveyor, the scope of the trials may be extended depending on the engine application.

18.1.2 For all stages of the works trials the pertaining operation values are to be measured and recorded by the engine manufacturer. All results are to be compiled in an acceptance protocol to be issued by the engine manufacturer.

18.1.3 In each case given in Table 2.18.1, all measurements conducted at the various load points shall be carried out at steady operating conditions. The readings for 100 per cent power (rated power at rated speed) are to be taken twice at an interval of at least 30 minutes.

18.1.4 The data to be measured and recorded, when testing the engine at various load points, are to include all necessary parameters for the engine operation. The crankshaft deflection is to be checked when this check is required by the manufacturer during the operating life of the engine. Crankshaft deflection measurements are to be taken before (cold condition) and after (hot condition) works acceptance trials.

18.1.5 Checks of components to be presented for inspection after the works trials are left to the discretion of the Surveyor.

Table 2.18.1 Scope of works trials for diesel engines

Main engines driving propellers and waterjets		
Trial condition	Duration	Note
100% power (rated power) at rated engine speed, *R*	≥ 60 minutes	After having reached steady conditions
110% power at engine speed corresponding to 1,032**R*	30–45 minutes	After having reached steady conditions (1)
90% (or maximum continuous power), 75%, 50% and 25%	—	Powers in accordance with the nominal propeller curve
Starting and reversing manoeuvres	—	—
Testing of governor and independent overspeed protective device	—	*See* 5.2
Shut down device	—	*See* 5.4
Engines driving generators		
Trial condition	Duration	Note
100% power (rated power) at rated engine speed, *R*	≥ 50 minutes	After having reached steady conditions (2)
110% power	15 minutes	After having reached steady conditions (2) (3)
75%, 50% and 25% power and idle run	—	(2)
Start-up tests	—	—
Testing of governor and independent overspeed protective device	—	*See* 5.3
Shut-down device	—	*See* 5.4

NOTES
1. After running on the test bed, the fuel delivery system of main engines is normally to be so adjusted that overload power cannot be given in service.
2. The test is to be performed at rated speed with a constant governor setting.
3. After running on the test bed, the fuel delivery system of diesel engines driving generators must be adjusted such that overload (110%) power can be given in service after installation on board, so that the governing characteristics including the activation of generator protective devices can be fulfilled at all times.

18.1.6 The Surveyor may require that after the trials the fuel delivery system is restricted so as to limit the engines to run at not more than 100 per cent power. The setting of the restriction is to be made as applicable to the intended fuel. Any restriction settings, and other changes to the engine's fuel injection equipment required for operation on special fuels, are to be recorded and included by the engine manufacturer.

18.1.7 For the duration of the acceptance test, no interventions or adjustments will be made to the machinery under test.

18.1.8 The testing of exhaust gas emissions is to comply with MARPOL as applicable.

18.1.9 For all stages that the engine is to be tested and where no duration is specified in Table 2.18.1, the load point is to be maintained for a sufficient period to allow pertaining values to be measured and recorded when the engine has achieved a steady operating condition.

18.2 Shipboard trials

18.2.1 After the conclusion of the running-in programme prescribed by the engine manufacturer, engines are to undergo shipboard trials as specified in Table 2.18.2. The scope of the trials is to be agreed between the LR Surveyor and the Shipyard prior to testing.

18.2.2 Engines driving generators or important auxiliaries are to be subjected to an operational test for at least 4 hours. During the test, the set concerned is required to operate at its rated power for an extended period. It is to be demonstrated that the engine is capable of supplying 100 per cent of its rated power, and in the case of shipboard generating sets account shall be taken of the times needed to actuate the generator's overload protection system.

Table 2.18.2 Scope of shipboard trials for diesel engines

Main engines driving fixed-pitch propellers (1) (2)		
Trial condition	Duration	Note
At rated engine speed, *R*	≥ 4 hours	—
At engine speed corresponding to normal continuous power	≥ 2 hours	—
At engine speed corresponding to 1,032**R*	30 minutes	Where the engine adjustment permits, *see* 18.1.6
At minimum on-load speed	—	—
Starting and reversing manoeuvres	—	*See* Section 8
In reverse direction of propeller rotation during the dock or sea trials at a minimum engine speed of 0,7**R*	10 minutes	—
Monitoring, alarms and safety systems	—	—
Where imposed, test to ensure engine can pass safely through barred speed range	—	—
Engines driving generators for propulsion		
Trial condition	Duration	Note
100% power (rated power) see 18.2.3	≥ 4 hours	(3) (4)
At normal continuous power	≥ 4 hours	(3) (4)
In reverse direction of propeller rotation at a minimum speed of 70% of the nominal propeller speed	10 minutes	(3) (4)
Starting manoeuvres	—	—
Monitoring, alarm and safety systems	—	—

NOTES
1. For main propulsion engines driving controllable pitch propellers, waterjets or reversing gears, the tests for main engines driving fixed-pitch propellers apply as appropriate.
2. Controllable pitch propellers are to be tested with various propeller pitches.
3. The tests are to be performed at rated speed with a constant governor setting.
4. Tests are to be based on the rated electrical powers of the driven generators.

18.2.3 In addition to 18.2.2, for engines driving generators for electric propulsion motors as well as auxiliaries, an operational test is to be carried out of at least 4 hours duration at a load which corresponds to 100 per cent of the electric propulsion motor(s) rated power. The astern/ahead manoeuvring capability of the propulsion system is to be demonstrated.

18.2.4 The suitability of an engine to burn residual or other special fuels is to be demonstrated, if the machinery installation is arranged to burn such fuels in service. *See also* Pt 6, Ch 1,7.2.1.

18.2.5 At the discretion of the attending Surveyor, the scope of the trials may be expanded in consideration of special operating conditions, such as towing, trawling, etc.

Part 5, Chapter 3
Steam Turbines

Effective date 1 July 2007

■ *Section 3*

Design and construction

3.8 Tuning gear

3.8.1 Turning gear is to be provided for all turbines to facilitate operating and maintenance regimes as required by the manufacturer.

~~*3.8.1*~~ *3.8.2* The turning gear for all propulsion turbines is to be power-driven and, if electric, is to be continuously rated.

3.8.3 The turning gear for auxiliary turbines may be hand operated (manual) except where this is not practicable, in which case the provision of 3.8.2 is to be complied with.

3.8.4 The turning gear for all turbines is to be fitted with safety interlocks which prevent steam valve actuation for turbine operation when engaged *see* Ch 1,3.9. Indication of engaged / not engaged is to be provided at all start positions.

3.8.5 The remote control device of power-driven turning gear is to be so designed that power is removed from the turning gear when the operating switch is released.

3.8.6 Means are to be provided to secure the turning gear when disengaged.

Part 5, Chapter 4
Gas Turbines

Effective date 1 July 2007

■ *Section 4*

Design and construction

4.10 Turning gear

4.10.1 Gas generator turning gear is to be provided to facilitate operating and maintenance regimes as required by the manufacturer.

4.10.2 The turning gear may be hand operated (manual) except where this is not practicable. If electrically driven, the motor is to be continuously rated.

4.10.3 The turning gear is to be fitted with safety interlocks which prevent engine operation when engaged, *see* Ch 1,3.9. Indication of engaged / not engaged is to be provided at all start positions.

4.10.4 The remote control device of power-driven turning gear is to be so designed that power is removed from the turning gear when the operating switch is released.

4.10.5 If permanently attached, means are to be provided to secure the turning gear when disengaged.

Part 5, Chapter 6
Main Propulsion Shafting

Effective date 1 July 2007

■ *Section 3*
Design

3.12 Sternbushes

3.12.1 The length of the bearing in the sternbush next to and supporting the propeller is to be as follows:

(a) For water lubricated bearings which are lined with lignum vitae, rubber composition or staves of approved plastics material, the length is to be not less than four times the diameter required for the screwshaft under the liner.

(b) For water lubricated bearings lined with two or more circumferentially spaced sectors of an approved plastics material, in which it can be shown that the sectors operate on hydrodynamic principles, the length of the bearing is to be such that the nominal bearing pressure will not exceed 5,5 bar (5,6 kgf/cm^2). The length of the bearing is to be not less than twice its diameter.

(c) For oil lubricated bearings of synthetic material the flow of lubricant is to be such that overheating, under normal operating conditions, cannot occur. The acceptable nominal bearing pressure will be considered upon application and is to be supported by the results of an agreed test programme. In general, the length of the bearing is not to be less than 2,0 times the rule diameter of the shaft in way of the bearing.

~~(c)~~ (d) For bearings which are white-metal lined, oil lubricated and provided with an approved type of oil sealing gland, the length of the bearing is to be approximately twice the diameter required for the screwshaft and is to be such that the nominal bearing pressure will not exceed 8,0 bar (8,1 kgf/cm^2). The length of the bearing is to be not less than 1,5 times its diameter.

~~(d)~~ (e) For bearings of cast iron and bronze which are oil lubricated and fitted with an approved oil sealing gland, the length of the bearing is, in general, to be not less than four times the diameter required for the screwshaft.

~~(e)~~ (f) For bearings which are grease lubricated, the length of the bearing is to be not less than four times the diameter required for the screwshaft.

3.12.3 Bearings of synthetic material are to be supplied finished machined to design dimensions within a rigid bush. Means are to be provided to prevent rotation of the lining within the bush during operation.

3.12.4 All sternbushes are to be adequately secured in the sterntube/housings.

Existing paragraphs 3.12.3 *to* 3.12.9 *have been renumbered* 3.12.5 *to* 3.12.11.

Part 5, Chapter 8
Shaft Vibration and Alignment

Effective date 1 July 2007

■ *Section 5*
Shaft alignment

5.4 Design and installation criteria

5.4.2 Design and installation of the shafting is to satisfy the following criteria:

(a) The Builder is to position the bearings and construct the bearing seatings to minimize the effects of hull deflections under any of the ship's operating conditions.

(b) Relative slope between the propeller shaft and the aftermost sterntube bearing is, in general, not to exceed 3 x 104 rad.

(c) Sterntube bearing loads are to satisfy the requirements of Ch 6,3.12.

(d) Evidence is to be provided to LR demonstrating that bearings of synthetic material have been verified as being within the tolerance stated by the bearing manufacturer for diameter, ovality, and straightness after installation.

~~(d)~~ (e) Bearings of synthetic material are to be verified as being within tolerance for ovalilty and straightness, circumferentially and longitudinally, after installation.

~~(e)~~ (f) The sterntube forward bearing static load is to be sufficient to prevent unloading in all static and dynamic operating conditions, including the transient conditions experienced during manoeuvring turns and during operation in heavy weather.

~~(f)~~ (g) Intermediate shaft bearings' loads are not to exceed 80 per cent of the bearing manufacturer's allowable maximum load, for plain journal bearings, based on the bearing projected area.

~~(g)~~ (h) Equipment manufacturer's bearing loads are to be within the manufacturer's specified limits, i.e. prime movers, gearing.

~~(h)~~ (j) Resulting shear forces and bending moments are to meet the equipment manufacturer's specified coupling condition.

~~(i)~~ (k) The manufacturer's radial, axial and angular alignment limits for the flexible couplings are to be maintained.

Part 5, Chapter 9
Strengthening for Navigation in Ice

Effective date 1 January 2007

■ *Section 1*
General

1.1 Class notations

1.1.3 Offshore supply ships strengthened in accordance with the requirements of Ice Class **1E** are only intended for navigation in very light first-year ice conditions. The requirements of Section 3 are to be complied with.

~~*1.1.3*~~ *1.1.4* For ships where the ice class notation Ice Class **1AS FS(+)**, Ice Class **1A FS(+)**, Ice Class **1B FS(+)** or Ice Class **1C FS(+)** is requested, the requirements of Sections 2 and 4 of this Chapter, in addition to the Finnish Swedish Ice Class Rules, in force at the time of contract, are to be complied with. The Finnish Swedish Ice Class Rules may be obtained from the following website: *www.fma.fi*

■ *Section 3*
Ice Class 1D and 1E

3.1 General

3.1.1 Where the notation Ice Class **1D** or Ice Class **1E** is desired, the requirements of this Section, in addition to those for open water service, are to be complied with.

3.1.2 For Ice Class **1D** or Ice Class **1E** , the total engine output is to be not less than determined by the following formula:

P = 0,72LB kW

(H = 0,98LB) Hp

where

L = Rule length, in metres, *see* Pt 3, Ch 1,6.1.1

B = moulded breadth of ship, in metres, *see* Pt 3, Ch 1,6.1.3.

Part 5, Chapter 10
Steam Raising Plant and Associated Pressure Vessels

Effective date 1 July 2007

■ *Section 14*
Construction

14.4 Welded-on flanges, butt welded joints and fabricated branch pieces

14.4.9 Socket weld joints are not to be used where fatigue, severe erosion, crevice corrosion or stress corrosion is expected to occur, for example, blow down, drain, scum and chemical dosing connections.

Part 5, Chapter 12
Piping Design Requirements

Effective date 1 July 2007

■ *Section 2*
Carbon and low alloy steels

2.8 Socket weld joints

2.8.1 Socket weld joints may be used in Class III systems with carbon steel pipes of any outside diameter. Socket weld fittings are to be of forged steel and the material is to be compatible with the associated piping. In particular cases, socket welded joints may be permitted for piping systems of Class I and II having outside diameter not exceeding 88,9 mm. Such joints are not to be used where fatigue, severe erosion or crevice corrosion is expected to occur or where toxic media are conveyed. *See also* Ch 10,14.4.9.

Part 5, Chapter 15
Piping Systems for Oil Tankers

Effective date 1 July 2007

■ *Section 1*
General requirements

1.6 Cargo pump room

Table 15.1.1 Alarms and safety arrangements

Item	Alarm	Note
Temperature sensing of ~~Bulkhead~~ bulkhead shaft glands, bearings and pump casings ~~temperature~~	High *see* Note 1	~~Any machinery item,~~ Cargo, ballast and stripping pumps
~~Pump bearing and casing temperature~~	~~High see Note 1~~	~~Any machinery item~~
Bilge level	High	—
Hydrocarbon concentaration	High *see* Note 2	> 10% LEL

NOTES
1. The alarm signals shall trigger continuous visual and audible alarms in the cargo control room or the pump control station.
2. This alarm signal shall trigger a continuous audible and visual alarm in the pump room, cargo control room, engine control room and bridge.

1.6.4 Alarms and safety arrangements are to be provided as indicated in 1.6.5 and Table 15.1.1. These requirements are applicable to pump rooms where pumps for cargo, such as cargo pumps, stripping pumps, pumps for slop tanks, pumps for COW or similar pumps are provided and not for pump rooms intended solely for ballast transfer. *See also* 1.6.6.

1.6.6 Where items of equipment other than described in Table 15.1.1 are located in the pump room and are driven by shafts passing through bulkheads, the potential risk of ignition of hydrocarbon gas is to be assessed and proposals for mitigation submitted to LR for consideration.

Effective date 1 January 2007

■ *Section 2*
Piping systems for bilge, ballast, oil fuel, etc.

2.4 Drainage of ballast tanks and void spaces within the range of the cargo tanks

2.4.2 Ballast pumps shall be provided with suitable arrangements to ensure efficient suction from ballast tanks.

2.4.3 Where submerged water ballast pumps are fitted, they are to be located in separate compartments on opposite sides of the ship such that, in the event of hull damage due to grounding or collision, the risk of total loss of ballast pumping capability is minimised.

~~2.4.2~~ *2.4.4* Ballast piping is not to pass through cargo tanks and is not to be connected to cargo oil piping. Provision may, however, be made for emergency discharge of water ballast by means of a portable spool connection to a cargo oil pump and where this is arranged, a non-return valve is to be fitted in the ballast suction to the cargo oil pump

~~2.4.3~~ *2.4.5* Consideration will be given to connecting double bottom and/or wing tanks, which are in the range of the cargo tanks, to pumps in the machinery space where the tanks are completely separated from the cargo tanks by cofferdams, heating ducts or containment spaces, etc.

2.6 Ballast piping in pump room double bottoms

2.6.1 Ballast piping is permitted to be located within the cargo pump room double bottom provided any damage to that piping does not render the ship's ballast and cargo pumps, located in the cargo pump room, ineffective.

Part 5, Chapter 22
Propulsion and Steering Machinery Redundancy

Effective date 1 July 2007

■ *Section 1*
General requirements

1.1 General

1.1.2 The requirements, which are optional, cover machinery arrangements and control systems necessary for ships which have propulsion and steering systems configured such that, in the event of a single failure of a system or item of active equipment, *see* 1.1.3, the ship will retain not less than 50 per cent of the installed prime mover capacity and not less than 50 per cent of the installed propulsion systems and retain steering capability at a service speed of not less than seven knots. 100 per cent propulsion power is the approved total power of all the main propulsion units at maximum continuous rating (MCR). The requirements also cover machinery arrangements where the propulsion and steering systems are installed in separate compartments such that, in the event of a loss of one compartment, the ship will retain availability of propulsion power and manoeuvring capability.

1.1.3 For the purpose of this Chapter, items of active equipment are those which have a defined function for operation of a propulsion or steering system, such as but not limited to:

- Prime movers, i.e. diesel engines, electric motors, steam turbines and gas turbines;
- Generators and their excitation equipment;
- Transformers and converters;
- Gearing and shafting systems;
- Propulsion devices, i.e. propellers, water-jets and thrusters;
- Pumps;
- Valves (where power actuated);
- Fuel treatment plant;
- Coolers/heaters;
- Filters;

Piping and electrical cables connecting items of active equipment are not considered to be active.

Existing paragraphs 1.1.3 *to* 1.1.5 *have been renumbered* 1.1.4 *to* 1.1.6.

■ *Section 2*
Failure Mode and Effects Analysis (FMEA)

2.1 General

2.1.1 A FMEA is to be carried out in accordance with 2.1.2 to 2.1.7 for the propulsion systems, electrical power supply systems and steering systems to demonstrate that a single failure in active equipment or loss of an associated sub-system, *see* 1.1.3, will not cause loss of all propulsion and/or steering capability as required by a class notation. Typical sub-systems include associated control and monitoring arrangements, data communications, power supplies (electrical, hydraulic or pneumatic), fuel, lubricating, cooling, etc.

■ *Section 3*
Machinery arrangements

3.1 Main propulsion machinery

3.1.1 For **PSMR**, **PSMR***, **PMR** and **PMR*** notations, independent main propulsion systems are to be provided so that the ship will retain not less than 50 per cent of the prime mover capacity and not less than 50 per cent of the installed propulsion systems in the event of a single failure of a system or active item of equipment, *see* 1.1.3. In the event of a single failure in equipment, the remaining system(s) is to be capable of maintaining a service speed of not less than seven knots and, for **PSMR** and **PSMR*** notations, give adequate manoeuvring capability, *see* 1.2.4.

Part 6, Chapter 1
Control Engineering Systems

Effective date 1 July 2007

■ *Section 1*
General requirements

1.1 General

1.1.8 LR will be prepared to give consideration to special cases or to arrangements which are equivalent to the Rules.

1.2 Plans

1.2.3 Plans for the control, alarm and safety systems of the following are to be submitted:

- Air compressors.
- Bilge and ballast systems.
- Cargo pumping systems for tankers.
- Cargo and ballast pumps in hazardous areas.
- Controllable pitch propellers.
- Electric generating plant.
- Fixed water based local application fire-fighting systems, *see* 2.9.
- Incinerators.
- Inert gas generators.
- Main propelling machinery including essential auxiliaries.
- Miscellaneous machinery or equipment (where control, alarm and safety systems are specified by other Sections of the Rules).
- Oil fuel transfer and storage systems.
- Steam raising plant. (Boilers and their ancillary equipment).
- Steering gear.
- Thermal fluid heaters.
- Transverse thrust units.
- Valve position indicating systems.
- Waste-heat boiler.
- Waterjets for propulsion purposes.
- Cargo tank, ballast tank and void space instrumentation where specified by other section of the Rules (e.g. water ingress detection).

■ *Section 2*
Essential features for control, alarm and safty systems

2.5 Control systems, general requirements

2.5.8 ~~Arrangements are to be such that machinery may be operated with the system of remote or automatic controls out of action.~~ Failure of a control system is not to result in the loss of ability to provide essential services by alternative means. This may be achieved by manual control or redundancy ~~arrangements~~ within the control system or redundancy in machinery and equipment, *see also* 2.12.2. Instrumentation is to be provided at local manual control stations to ensure effective operation of the machinery.

2.8 Fire detection alarm systems

2.8.1 Where an automatic fire detection system is to be fitted in a machinery space the requirements of 2.8.2 to 2.8.14 are to be satisfied. *See also* SOLAS 1974 as amended Reg. II-2/C,7, or Ch 4,4~~,~~ as applicable.

2.9 Fixed water-based local application fire-fighting systems

2.9.1 Where fixed water-based local application fire-fighting systems are installed in accordance with SOLAS as amended Ch. II-2/C, Reg. 10.5.6, arrangements are to be in accordance with this sub-Section.

2.9.2 Systems are to be available for immediate use and arranged for manual activation from inside and outside the protected space. *See also* Ch 2,16.3.4.

2.9.3 The activation of a system is not to result in loss of electrical power or reduction of the manoeuvrability of the ship and is not to require confirmation of space evacuation or sealing.

2.9.4 A control panel is to be provided for managing actions such as opening of valves, starting of pumps and sounding of alarms and processing information from detectors.

2.9.5 Alarms are to be initiated upon activation of a system and are to indicate the specific zone activated at the control panel. Alarms are to be provided in each protected space, at an attended machinery control station and in the wheelhouse. The audible alarm is to be distinguishable from other safety system alarms.

2.9.6 Where SOLAS requires the system to, additionally, be capable of automatic release, the arrangements are to be in accordance with 2.9.7 to 2.9.9.

2.9.7 A minimum of two fire detectors is to be provided for each protected area. One is to be a flame detector and the other is to be a smoke or heat detector, as considered appropriate to the nature of the risk and ambient conditions. The system is to be activated upon detection by two of the detectors. A fault in one detector is to initiate an alarm and is not to inhibit activation of the system under the control of the other detector.

2.9.8 A fire detection alarm system panel in accordance with 2.8 may be used for receiving fire detection signals. Separate loops are not required provided that the address of the initiating device can be identified at the control panel. The received signals are then to be sent to the control panel required by 2.9.4 for processing and action.

2.9.9 The system's fire detection systems and control units are to meet the performance criteria of SOLAS Ch II/C, Reg. 7 and satisfy the requirements of LR's *Type Approval System Test Specification Number 1 (2002).*

Existing sub-Sections 2.9 *to* 2.12 *have been renumbered* 2.10 *to* 2.13*.*

~~2.9~~ 2.10 Programmable electronic systems – General requirements

~~*2.9.7*~~ *2.10.7* Programmable electronic equipment is to be provided with self-monitoring capabilities such that hardware and functional failures will initiate an audible and visual alarm in accordance with the requirements of 2.3 and, where applicable, 4.2. Hardware failure indications are to ~~be indicated at least at module level~~ enable faults to be identifiable at least down to the level of the lowest replaceable unit and the self-monitoring capabilities are to ensure that diagnostic information is readily available.

~~*2.9.18*~~ *2.10.18* ~~Mimic diagrams are to clearly identify unreliable data.~~ Where systems detect fault conditions, any affected mimic diagrams are to ensure that the status of unreliable and incorrect data is clearly identified.

~~*2.9.19*~~ *2.10.19* Multi-function displays and controls are to be duplicated and interchangeable where used for the control or monitoring of more than one system, machinery item or item of equipment. At least one unit at the main control station is to be supplied from an independent uninterruptible power ~~supply~~ system (UPS).

■ *Section 3*
Control and supervision of unattended machinery

3.9 Auxiliary engines and auxiliary steam turbines

Table 1.3.8 Auxiliary engines and auxiliary steam turbines: Alarms and safeguards (*Part only shown*)

Item	Alarm	Note
Exhaust gas temperature	High	Per cylinder. For engine power ~~>~~<500 kW/cylinder, common sensors for each inlet to the turbocharger may be accepted

3.15 Miscellaneous machinery

Table 1.3.12 Miscellaneous machinery: Alarms and safeguards (*Part only shown*)

Item	Alarm	Note
~~Daily~~ Oil fuel service ~~oil fuel~~ tanks level	High and Low	~~One~~ Where a common overflow tank is fitted, a high level alarm in the common overflow tank may be ~~fitted in a common overflow tank~~ accepted
~~Daily~~ Oil fuel service ~~oil fuel~~ tanks temperature	High	Where heating arrangements are fitted

3.15.6 **Oil fuel tanks**. Means are to be provided to eliminate the possibility of overflow from ~~daily service~~ oil fuel service tanks into the machinery space and to safeguard against overflow of oil from ~~the daily service~~ oil fuel service tanks through the air pipe. *See* Pt 5, Ch 13 regarding the termination of air pipes.

Part 6, Chapter 2
Electrical Engineering

Effective date 1 July 2007

■ *Section 1*
General requirements

1.2 Plans

(*Part only shown*)

1.2.8 Details of electrically-operated fire, ship, crew and passenger emergency safety systems which are to include typical single line diagrams and arrangements, showing main vertical and, where applicable, horizontal fire zones and the location of equipment and cable routes to be employed for:

(a) emergency lighting;

(b) accommodation fire detection, alarm and extinction systems;

(c) Fixed water-based local application fire-fighting systems;

~~(c)~~ (d) public address system;

~~(d)~~ (e) general alarm;

~~(e)~~ (f) watertight doors, bow, stern and shell doors and other electrically operated closing appliances.

~~(f)~~ (g) low location lighting.

NOTE:

A general arrangement plan of the complete ship showing the main vertical fire zones and the location of equipment and cable routes, for the above systems, is to be made available for the use of the Surveyor on board.

1.3 Surveys

1.3.2 Details of electrically-operated fire, ship, crew and passenger The following equipment, where intended for use for essential and emergency services, is to be surveyed by the Surveyors during manufacture and testing:

- Converting equipment of 100 kW and over;
- Rotating machines of 100 kW and over;
- Switchboards and section boards; and
- UPS units of 50 kVA and over.

1.5 Definitions

1.5.11 'Dead ship condition' means that the entire machinery installation, including the power supply, is out of operation and that the auxiliary services for bringing the main propulsion systems into operation (e.g. compressed air, starting current from batteries, etc.) and for the restoration of the main power supply are not available. ~~It is assumed that means~~ Means are to be available to start the emergency generator at all times, *see* Pt 5, Ch 2,8.5.

1.5.12 Protected space is a machinery space where a fixed water-based local application fire-fighting system is installed.

1.5.13 Protected areas are areas within a protected space which is required to be protected by a fixed water-based local application fire-fighting system.

1.5.14 Adjacent areas are areas, other than protected areas, exposed to direct spray or other areas where water may extend when a fixed water-based local application fire-fighting system is activated.

1.7 Quality of power supplies

CORRIGENDUM

1.7.3 **Harmonics**. Unless specified otherwise, the total harmonic distortion (THD) of the voltage waveform at any a.c. switchboard or section board is not to exceed 8 per cent of the fundamental for all frequencies up to 50 times the supply frequency and no voltage at a frequency above 25 times supply frequency is to exceed 1,5 per cent of the fundamental of the supply voltage. THD is the ratio of the rms value of the harmonic content to the rms value of the fundamental, expressed in per cent and may be calculated using the expression:

$$\text{~~}V_T\text{~~ } THD = \frac{\sum_{h=2}^{\infty} V_h^2}{V_1} \times 100$$

where

~~V_T = total harmonic voltage~~

V_h = rms amplitude of a harmonic voltage of order h

V_1 = rms amplitude of the fundamental voltage.

Effective date 1 July 2007

1.7.4 Unless specified otherwise, d.c. electrical equipment is to operate satisfactorily with the following simultaneous variations, from their nominal value, when measured at the consumer input terminals:

(a) When supplied by d.c. generator(s) or a rectified a.c. supply:

Voltage tolerance (continuous) ±10%
Voltage cyclic variation deviation 5%
Voltage ripple 10%
(a.c. rms over steady state d.c. voltage);

(b) When supplied by batteries:

(i) Equipment connected to the batteries during charing:Voltage tolerance +30%, –25%;

(ii) Equipment not connected to batteries during charging:Voltage tolerance +20%, –25%.

Different voltage variations as determined by the charging/discharging characteristics, including ripple voltage from the charging device, may be considered. When battery chargers/battery combinations are used as d.c. power supply systems adequate measures are to be taken to keep the voltage within the specified limits during charging, boost charging and discharging of the battery.

1.14 Operation under fire conditions

1.14.1 As a minimum, the following emergency services and their emergency power supplies, are required to be capable of being operated under fire conditions:

- Control and power systems to power-operated fire doors and status indication for all fire doors.
- Control and power systems to power-operated watertight doors and their status indication.
- Emergency lighting.
- Fire and general alarms.
- Fire detection systems.
- Fire-extinguishing systems and fire-extinguishing media release alarms.
- Fire safety stops, *see also* 16.6.
- Low location lighting, *see also* 17.4.3.
- Public address systems.
- Emergency fire pump.

1.15 Protection of electrical equipment against the effects of lightning strikes

1.15.1 ~~In addition to the primary protection requirements in Section 19, precautions~~ Precautions are to be taken to protect essential electronic equipment that may be susceptible to damage from voltage pulses attributable to the secondary effects of lightning. This may be achieved by suitable design and/or the use of additional protective devices, such as surge arrestors. Resultant induced voltages may be further reduced by the use of earthed metallic screened cables. *See also* Section 19.

■ *Section 2*
Main source of electrical power

2.3 Starting arrangements

2.3.2 Where the emergency source of electrical power is required to be used to restore propulsion from a 'dead ship condition', the emergency generator is to be capable of providing initial starting energy for the propulsion machinery within 30 minutes of the 'dead ship condition'. The emergency generator capacity is to be sufficient for restoring propulsion in addition to supplying those services in Section 3. See Pt 5, Ch 2,8.1.1 for ~~initial~~ dead ship condition starting arrangements.

■ *Section 3*
Emergency source of electrical power

3.2 Emergency source of electrical power in passenger ships

3.2.12 In order to ensure the ready availability of the emergency source of electrical power to supply emergency circuits, arrangements are to be made, where necessary, ~~when the generator is overloaded,~~ to automatically disconnect ~~sufficient~~ non-emergency circuits from the emergency switchboard to ensure ~~its continued safe operation~~ that electrical power is available to the emergency circuits. The arrangements are to automatically disconnect sufficient non-emergency loads to ensure continued safe operation of the emergency source of electrical power in the event of overloading.

3.3 Emergency source of electrical power in cargo ships

3.3.12 In order to ensure the ready availability of the emergency source of electrical power to supply emergency circuits, arrangements are to be made, where necessary, ~~when the generator is overloaded~~, to automatically disconnect ~~sufficient~~ non-emergency circuits from the emergency switchboard to ensure ~~its continued safe operation~~ that electrical power is available to the emergency circuits. The arrangements are to automatically disconnect sufficient non-emergency loads to ensure continued safe operation of the emergency source of electrical power in the event of overloading.

■ *Section 6*
System design Protection

6.1 General

6.1.6 ~~Protection~~ Except where arrangements comply with 11.3.5, protection for battery circuits is to be provided at a position external and adjacent to the battery compartments.

■ *Section 7*
Switchgear and control gear assemblies

7.11 Instruments for alternating current generators

7.11.4 Where the indications of voltage, frequency, current and power are displayed digitally, ~~in order to facilitate manual synchronising,~~ the indications ~~required by 7.11.3~~ are to be separately displayed.

■ *Section 9*
Converter equipment

9.2 Semiconductor equipment

9.2.18 Tests at the manufacturer's works of converter equipment and any associated reactors or filters are to include the high voltage test of 20.1, a temperature rise test, ~~where practical~~, on one of each size and type of converter equipment, and such other tests as may be necessary to demonstrate the suitability of the equipment for its intended duty. ~~Where a temperature rise test cannot be carried out at the manufacturer's works, it is to form part of the sea trials programme.~~ Details of tests are to be submitted for consideration when required, *see also* 1.3.2.

9.3 Uninterruptible power systems

9.3.1 Where uninterruptible power systems (UPS) are required to maintain essential services or provide emergency services, the requirements of this sub-Section apply. This sub-Section is in addition to the requirements of 9.1 to 9.2 and Section 11, as applicable.

9.3.2 UPS units are to be constructed in accordance with IEC 62040: *Uninterruptible power systems (UPS)*, or an acceptable and relevant National or International Standard.

9.3.3 The operation of a UPS is not to depend upon external services.

9.3.4 The type of UPS unit employed, whether off-line, line-interactive or on-line, is to be appropriate to the power supply requirements of the connected load equipment.

9.3.5 An external bypass, that is hardwired and manually operated, is to be provided for UPS to allow isolation of UPS for safety during maintenance and maintain continuity of load power.

9.3.6 UPS units are to be monitored and an audible and visual alarm is to be initiated in the navigating bridge or the engine control room, or an equivalent attended location for:

- power supply failure (voltage and frequency) to the connected load;
- earth fault;
- operation of battery protective device;
- battery discharge; and
- bypass in operation for on-line UPS units.

9.3.7 UPS units required to provide emergency services are to be suitably located for use in an emergency.

9.3.8 UPS units utilising valve-regulated sealed batteries may be located in compartments with standard marine or industrial electrical equipment provided that the arrangements comply with 11.3.5. Ventilation arrangements in accordance with IEC 62040: Uninterruptible power systems (UPS), or an acceptable and relevant National or International Standard, may be considered to satisfy the requirements of 11.5.10.

9.3.9 Output power is to be maintained for the duration required for the connected equipment.

9.3.10 The UPS battery capacity is, at all times, to be capable of supplying the designated loads for the time specified. Where it is proposed that additional circuits are connected to the UPS unit, details verifying that the UPS unit has adequate capacity are to be submitted for consideration, *see* 1.4.

9.3.11 On restoration of the input power, the rating of the charge unit is to be sufficient to recharge the batteries while maintaining the output supply to the load equipment.

9.3.12 Tests at the manufacturer's works are to include such tests necessary to demonstrate the suitability of a UPS unit for its intended duty and location. This is expected to include as a minimum the following tests:

- a temperature rise test and battery capacity test on one of each size and type of UPS;
- the high voltage test of 20.1;
- a ventilation rate test; and
- functional testing, including operation of alarms.

Details of tests are to be submitted for consideration when required, *see also* 1.3.2.

9.3.13 Where the supply is to be maintained without a break following a power input failure, this is to be verified after installation by practical testing.

■ *Section 10*
Electric cables and busbar trunking systems (busways)

10.5 Construction

10.5.1 Electric cables are to be at least of a flame-retardant type. ~~Compliance with IEC 60332-1: Tests on a single vertical insulated wire or cable~~ IEC 60332-1-2: *Tests on electric and optical fibre cables under fire conditions – Part 1-2: Test for vertical flame propagation for a single insulated wire or cable – Procedure for 1 kW pre-mixed flame*, will be acceptable.

10.5.3 Where electric cables are required to be of a 'fire resistant type', they are in addition to be easily distinguishable and comply with the performance requirements of the appropriate part of IEC 60331: ~~Fire characteristics of electric cables~~ *Tests for electric cables under fire conditions – Circuit integrity, when tested with a minimum flame application time of 90 minutes*, as follows:

- IEC 60331-21: *Procedures and requirements – Cables of rated voltage up to and including 0.6/1.0 kV*;
- IEC 60331-23: *Procedures and requirements – Electric data cables*;
- IEC 60331-25: *Procedures and requirements – Optical fibre cables*; or
- IEC 60331-31: *Procedures and requirements – Cables of rated voltage up to and including 0.6/1.0 kV*, where the overall diameter of the cable exceeds 20 mm.

10.8 Installation of electric cables

10.8.8 Where electric cables are installed in bunches, provision is to be made to limit the propagation of fire. This requirement is considered satisfied when cables of the bunch have been tested in accordance with the requirements of ~~IEC 60332-3, Category A/F~~ IEC 60332: *Tests on electric cables under fire conditions, Part 3-22, Test for vertical flame spread of vertically-mounted bunched wires or cables – Category A*, and are installed in the same configuration(s) as are used for the test(s). If the cables are not so installed, information is to be submitted to satisfactorily demonstrate that suitable measures have been taken to ensure that an equivalent limit of fire propagation will be achieved for the configurations to be used. Particular attention is to be given to cables in:

- atria or equivalent spaces; and
- vertical runs in trunks and other restricted spaces.

In addition, cables that comply with the requirements of ~~IEC 60332-3~~ IEC 60332-3-23 are also required to meet the requirements of ~~IEC 60332-1~~ IEC 60332-1-2.

■ *Section 11*
Batteries

11.3 Location

11.3.10 Only electrical equipment necessary for operational reasons and for the provision of lighting is to be installed in compartments provided in compliance with 11.3.1. Such electrical equipment is to be certified for group IIC gases and temperature Class T1 in accordance with IEC 60079: *Electrical apparatus for explosive gas atmospheres*, or an acceptable and relevant National Standard.

~~11.7 Electrical equipment~~

~~*11.7.1* Only electrical equipment necessary for operational reasons and for the provision of lighting is to be installed in compartments provided in compliance with 11.3.1. Such electrical equipment is to be certified for group IIC gases and temperature Class T1 in accordance with IEC 60079: Electrical apparatus for explosive gas atmospheres, or an acceptable and relevant National Standard.~~

Existing sub Section 11.8 *has been renumbered* 11.7.

Effective date 1 January 2007

■ *Section 13*
Electrical equipment for use in explosive gas atmospheres or in the presence of combustible dusts

13.1 General

13.1.1 The installation of electrical equipment in spaces and locations in which flammable mixtures are liable to collect ~~areas containing flammable gas or vapour and/or combustible dust~~, is to be minimized as far as is consistent with operational necessity and the provision of lighting, monitoring, alarm or control facilities enhancing the overall safety of the ship.

~~*13.1.2* Compliance with IEC 60092-502: *Electrical Installations in Ships - Tankers – Special Features*, may be accepted as meeting the requirements of 13.9, 13.10 and 13.11.~~

13.1.2 In order to eliminate potential sources of ignition from spaces and locations in which flammable mixtures are liable to collect, in accordance with SOLAS 1974 as amended, Chapter II-1, Regulation 45, such dangerous or hazardous areas are to be identified and electrical equipment within these areas is to be selected and installed in accordance with the requirements of this Section.

13.2 Selection of equipment

13.2.2 Consideration may be given to the use of equipment of the following types:

(a) equipment such as control panels, protected by purging and pressurization and capable of being verified by inspection as meeting the requirements of IEC 60079-2;

(b) simple non-energy-storing apparatus having negligible surface temperature rise in normal operation, such as limit switches, strain gauges, etc, incorporated in intrinsically-safe circuits;

(c) radio aerials having robust construction, meeting the relevant requirements of IEC 60079-15. Additionally, in the case of transmitter aerials, it is to be shown, by detailed study or measurement, or by limiting the peak radiated power and field strength to 1 W and 30 V/m, respectively, that they present negligible risk of inducing incendive sparking in adjacent structures or equipment;

(d) electrical apparatus with type of protection 'n' or 'N' provided it is in a well ventilated area on open deck and not within 3 m of any flammable gas or vapour outlet;

(e) electrical apparatus selected in accordance with IEC 60092-502: *Electrical Installations in Ships – Tankers – Special Features*, *see* 13.9 to 13.11.

13.9 Requirements for tankers intended for the carriage in bulk of oil cargoes having a flash point not exceeding 60°C (closed-cup test)

13.9.1 Paragraphs 13.9.5 to 13.9.14 define the electrical equipment permitted within dangerous zones and spaces and are to be read in conjunction with 13.1 to 13.8.

13.9.1 In order to eliminate potential sources of ignition from hazardous areas onboard tankers in accordance with SOLAS 1974 as amended, Chapter II-1, Regulation 45.11, electrical equipment is to be selected and installed in accordance with IEC 60092: *Electrical installations in ships – Part 502: Tankers – Special features*.

13.9.2 The requirements for cargo tanks also apply to cargo slops tanks.

13.9.3 The relevant gas group and temperature class for safe-type equipment in the defined locations are IIA T3.

13.9.4 Where intrinsically safe equipment is required, consideration will be given to the use of simple apparatus incorporated in intrinsically safe circuits, as defined in 13.2.2(b).

13.9.5 **Cargo tanks**: intrinsically safe equipment of category 'ia'.

13.9.6 **Cofferdams adjoining cargo tanks**:

(a) intrinsically safe equipment of category 'ia';

(b) electric depth sounding devices hermetically enclosed, located clear of the cargo tank bulkhead, with cables installed in heavy gauge steel pipes with gastight joints up to the main deck;

(c) cables for impressed current cathodic protection systems (for external hull protection only) installed in heavy gauge steel pipes with gastight joints up to the upper deck; the arrangements are to comply with Pt 3, Ch 2,3.5.3;

(d) through runs of cables, installed in heavy gauge steel pipes with gastight joints.

13.9.7 **Cargo pump rooms**:

(a) intrinsically safe equipment;

(b) electrical equipment as defined in 13.9.6(b) and (c);

(c) flameproof lighting fittings (symbol 'd'), *see* 5.7.3;

(d) pressurized lighting fittings (symbol 'p') of either the air driven type, or pressurized from an external source of protective gas and arranged to be de-energized automatically on loss of pressurization, *see* 5.7.3;

(e) gas detector heads having sinter-type flametrap protection, included within an intrinsically safe circuit; the gas detector system is to be certified;

(f) general alarm sounders of flameproof type, without internal sparking contacts;

(g) through runs of cables, confined to pump room entrances only, installed in heavy gauge steel pipes with gastight joints;

13.9.8 **Spaces under cargo tanks (e.g. duct keels)**: Electrical equipment as defined in 13.9.6(a) and (b) and 13.9.7(c) to (f).

13.9.9 **Enclosed or semi-enclosed spaces immediately above cargo tanks or having bulkheads immediately above and in line with cargo tank bulkheads (unless protected by diagonal plate in accordance with Pt 4, Ch 9,1.2.7), compartments for cargo hoses, spaces other than cofferdams adjoining and below the top of a cargo tank, e.g. trunks, passageways and holds**:

(a) intrinsically safe equipment; this is to be of category 'ia' where the spaces or compartments are not mechanically ventilated;

(b) safe type lighting fittings, *see* 5.7.3;

(c) through runs of cable;

(d) general alarm sounders as defined by 13.9.7(f).

13.9.10 **Zones on open deck within 3 m of any cargo oil tank outlet or vapour outlet (e.g. cargo tank or cofferdam hatch; sight port; tank cleaning opening; ullage opening; sounding pipe; cargo pump room entrance and ventilation intakes and exhausts), zones on open deck over all cargo tanks (including all ballast tanks within the cargo tank area) to the full width of the vessel, plus 3 m forward of the forward most cargo tank bulkhead and 3 m aft of the aft most cargo tank bulkhead, or any spillage barrier installed aft of the aft most cargo tank bulkhead, up to a height of 2,4 m above the deck**:

(a) safe type equipment;

(b) through runs of cable; cable expansion bends are not to be within 3 m of any cargo tank or vapour outlet.

13.9.11 **Zones within 5 m of any openings for pressure release required by Pt 5, Ch 15,4.1.2(a) and, at any height, within a cylinder of 10 m radius, (measured horizontally) above, and within a 3 m radius below any vent outlets required by Pt 5, Ch 15,4.1.2(b)**:

(a) safe type equipment;

(b) through runs of cable.

13.9.12 **Spaces below the level of, and having direct openings onto, the main deck, but outside the dangerous zone previously described**:

(a) safe type equipment;

(b) through runs of cable.

13.9.13 **Mechanically ventilated or pressurized spaces**:

(a) where a space of the type defined by 13.9.12 is provided with a self closing door for the opening onto the main deck and has mechanical ventilation, the air intake for which is remote from any dangerous space or zone, non-safe type equipment is permitted within the space;

(b) where a space opening into a dangerous zone or space is provided with an airlock; is separated from the cargo by at least two gastight bulkhead, and is pressurized in accordance with 13.7, non-safe type equipment is permitted within the space.

13.9.14 Electrical installations in enclosed or semi-enclosed spaces having a direct opening into any dangerous space or zone are to comply with the requirements for the space or zone to which the opening leads.

13.12 Special requirements for ships with spaces for carrying vehicles with fuel in their tanks, for their own propulsion

13.12.4 **Cargo ships with closed ro-ro cargo spaces for carrying vehicles:**

(a) except where exempted by (b) electrical equipment fitted within the space and within the exhaust ventilation trunking for the space is to be of a safe-type;

(b) where the ventilation system required by SOLAS ~~Reg. II-2/C, 53.2.3~~ 1974 as amended, Chapter II-2, Regulation 20.3.1.1.1 is arranged to operate continuously and is sufficient to provide at least ten air changes per hour, whenever vehicles are on board, above a height of 45 cm from the vehicle deck, or any platform on which vehicles are carried, electrical equipment having an enclosure of ingress protection rating of at least IP 55 may be accepted as an alternative to that of a safe-type;

(c) all electrical circuits terminating in the cargo space are to be provided with multipole linked isolating switches located outside the cargo hold. Provision is to be made for locking in the off position. This does not apply to safety circuits such as those for fire, smoke or gas detection.

13.13 Special requirements for ships intended for the carriage of dangerous goods

13.13.1 In order to eliminate potential sources of ignition in enclosed cargo spaces or vehicle spaces in accordance with SOLAS 1974 as amended, Chapter II-2, Regulation 19.3.2, and from associated hazardous areas (*see* 13.4.2), electrical equipment is to be selected in accordance with 13.13.2 and 13.13.3 and installed in accordance with 13.3 and ~~13.13.3 to 13.13.6~~ 13.13.4 to 13.13.7.

13.13.3 In addition to the requirements of IEC 60092-506, pipes such as ventilation and bilge pipes, having ends opening into a hazardous area are to be considered a hazardous area. Enclosed spaces such as pipe tunnels and bilge pump rooms containing such pipes and with equipment and components such as pumps, valves and flanges are to be considered as extended hazardous areas unless protected by overpressure.

~~*13.13.3*~~ *13.13.4* Electrical equipment not essential for the safety or operation of the ship and which is not of a certified safe type is to be completely disconnected and protected against unauthorised re-connection. Disconnection is to be made outside the hazardous areas and be effected with isolating links or lockable switches.

~~*13.13.4*~~ *13.13.5* Electrical equipment and all cables, including through runs and terminating cables, are to be protected against mechanical damage. Cables are to be either enclosed in screwed heavy gauge steel drawn or seam-welded and galvanized conduit, or protected by electrically continuous metal sheathing or metallic wire armour braid or tape.

~~*13.13.5*~~ *13.13.6* Cables joints in cargo spaces are to be avoided where possible. Where joints are unavoidable, they are to be enclosed in metal-clad or impact strength plastic junction boxes of certified safe type (*see* 13.13.2) or heat-shrink or encapsulated crimp sleeve cable joints.

~~*13.13.6*~~ *13.13.7* Cable penetrations of decks and bulkheads are to be sealed against the passage of gas or vapour.

Effective date 1 July 2007

■ *Section 16*
Fire safety systems

16.1 Fire detection and alarm system

16.1.4 The fire control panel is to be located on the navigating bridge or in ~~the~~ a central fire control station (~~*see* Ch 4,2.4~~) and may form part of that panel specified in Ch 1,2.8.2. For passenger ships carrying more than 36 passengers, the fire control panel is to be located in the continuously manned central control station.

16.1.15 The wiring for each section of detectors in an addressable fire detector system is to be separated as widely as practicable from that of all other sections on the same loop. Where practicable no loop is to pass through a space twice. When this is not practical, such as in large public spaces, the part of the loop which by necessity passes through the space for a second time is to be installed at the maximum possible distance from other parts of the loop.

16.2 Automatic sprinkler system

16.2.2 For **passenger ships**, electrically-driven sea-water pumps for automatic sprinkler systems are to be served by not less than two circuits reserved solely for this purpose, one fed from the main source of electrical power and one from the emergency source of electrical power. Such feeders are to be connected to an automatic changeover switch situated near the sprinkler pump and the switch is to be normally closed to the feeder from the main source of electrical power. No other switches are permitted in the feeders. The switches on the main and emergency switchboards are to be clearly labelled and normally kept closed.

16.3 Fixed water-based local application fire-fighting systems

16.3.1 Where fixed water-based local application fire-fighting system pressure sources are reliant on external power they need only be supplied by the main source of electrical power. However, where the system forms a section of the main fixed fire-extinguishing system the power supply arrangements are to be equivalent to those required by 16.2.2.

16.3.2 The fire detection, control and alarm systems are to be provided with an emergency source of electrical power required by 3.2 or 3.3 and are also to be connected to the main source of electrical power. Separate feeders, reserved solely for this purpose, with automatic changeover facilities located in, or adjacent to, the main control panel are to be provided.

16.3.3 Failure of any power supply is to operate an audible and visual alarm. *See also* 1.13 and 1.14.

16.3.4 Means to activate a system are to be located at easily accessible positions inside and outside the protected space. Arrangements inside the space are to be situated such that they will not be cut off by a fire in the protected areas and are suitable for activation in the event of escape. Proposals to install local activation means outside protected spaces are to be submitted for consideration.

16.3.5 For the electrical safety of electrical and electronic equipment in areas protected by fixed water-based local application fire-fighting systems and adjacent areas where water may extend, the requirements of 16.3.6 to 16.3.8 apply.

16.3.6 Unless essential for safety or operational purposes, electrical and electronic equipment is not to be located within protected areas or adjacent areas. The pump, its electrical motor and the sea valve if any, may be in a protected space provided that they are outside areas where water or spray may extend.

16.3.7 Electrical and electronic equipment located within protected areas and those within adjacent areas exposed to direct spray are to have a degree of protection not less than IP44.

16.3.8 Electrical and electronic equipment within adjacent areas not exposed to direct spray may have a lower degree of protection than IP44 provided evidence of suitability for use in these areas is submitted, including details of the design and equipment layout and arrangements to prevent or restrict the ingress of water mist/spray. Cooling airflow for equipment is to be assured.

Existing sub-Sections 16.3 *to* 16.8 *have been renumbered* 16.4 *to* 16.9.

~~16.5~~ 16.6 Fire safety stops

~~*16.5.2*~~ *16.6.2* To control air supply, a means of stopping all forced and induced draught~~s~~ fans, and all ventilation fans serving accommodation spaces, service spaces, control stations and machinery spaces from an easily accessible position outside of the space being served is to be provided. The position is not to be readily cut off in the event of a fire in the spaces served by the fans.

~~*16.5.3*~~ *16.6.3* In passenger ships carrying more than 36 passengers, a second means of stopping ~~ventilating~~ ventilation fans serving accommodation spaces, service spaces and control stations is to be provided at a position as far apart from the position required by 16.5.3 as is practicable. At both positions, the controls are to be grouped so that all fans can be stopped from either of the two positions.

~~*16.5.5*~~ *16.6.5* In passenger ships, the means of stopping machinery ventilation fans required by 16.5.3 is to be located at the central control station which is to have safe access from the open deck. The central control station is to be provided with ventilation fan ~~off~~ OFF status indications together with a means for restarting the ventilation fans.

~~*16.5.6*~~ *16.6.6* To control flammable liquids, a means of stopping all fuel oil, lubricating oil, hydraulic oil, cargo oil and thermal oil pumps, oil purifiers from outside the spaces being served is to be provided. The position is not to be cut off in the event of a fire.

Existing sub-Section 16.5.4 *has been renumbered* 16.6.4.

■ *Section 17*
Crew and passenger emergency safety systems

17.4 Escape route or low location lighting (LLL)

17.4.2 The LLL system is to be provided with an emergency source of electrical power as required by 3.2 and also be connected to the main source of electrical power, with automatic changeover facilities located adjacent to the control panel, *see also* 1.14.

■ *Section 18*
Ship safety systems

18.2 Stern and side shell doors

Existing paragraphs 18.2.3 *to* 18.2.11 *have been renumbered* 18.2.1 *to* 18.2.9.

~~*18.2.1*~~ *18.2.10* Doors with a clear opening area of 12 m^2 or greater are to be provided with closing devices operable from a remote control position. Doors which are located partly or totally below the freeboard deck with a clear opening area greater than 6 m^2 are to be provided with an arrangement for remote control from a position above the freeboard deck. This remote control is to provide centralised control for:

(a) The closing and opening of the doors.
(b) Associated securing and locking devices.

~~*18.2.2*~~ *18.2.11* The location of the remote control panel is to be such that door operation can be easily observed by the operator or by other suitable means such as closed circuit television. Where remote control is required, television surveillance or other such means may satisfy this requirement.

Part 6, Chapter 3
Refrigerated Cargo Installations

Effective date 1 July 2007

■ *Section 1*
General requirements

1.6 Notation and temperature conditions

1.6.1 The class notation assigned will state the minimum temperature or a temperature range approved by the Committee for the installation with the maximum sea temperature stated, e.g. '✠ Lloyd's RMC to maintain temperature(s) of minus 29°C to plus 14°C with sea temperature plus 32°C maximum'.

1.10 Spare gear and refrigerant charge

1.10.2 For systems complying with 2.5.6 sufficient carbon dioxide is to be carried on board to allow the refrigeration system to be fully recharged. In addition, adequate reserve supplies of refrigerant are to be carried for maintenance purposes. The replacement refrigerant is to be stored in containers complying with 3.3.5.

2.5 Design pressures

2.5.6 Due to the low critical temperature of carbon dioxide it is inappropriate to determine the design pressure in accordance with 2.5.3. The proposed design pressure for a carbon dioxide system is to be stated, taking account of the maximum working pressure and the maximum pressure at rest conditions. Where the maximum pressure at rest condition is maintained by the fitting of a supplementary refrigeration unit, condensing the vapour in a holding vessel, supporting calculation is to be provided to show that this can be undertaken with a local ambient temperature of 45°C. The holding vessel is to be thermally insulated to prevent the operation of the relief devices within a 24 hour period after stopping the supplementary refrigeration unit at an ambient temperature of 45°C and an initial pressure equal to the starting pressure of the refrigeration unit.

2.5.7 Where a carbon dioxide system is designed for hot gas defrosting, due regard is to be given to the possibility of a higher pressure being imposed on the low pressure system. The design pressure for this section of the system shall be 10 per cent above the maximum pressure experienced during defrosting.

■ *Section 2*
Design criteria

2.2 Refrigerants and classes of pipes

Table 3.2.1 Primary refrigerants and their class of pipe

Refrigerant	Type	Composition	Class of Pipe Class I	Class II	Class III
R717 (Ammonia)	NH_3	–	✓	–	–
R22	HCFC	–	–	✓	–
R134a	HFC	–	–	–	✓
R407C	Blend	R32, R125, R134a	–	✓	–
R410B	Blend	R32, R125	–	✓	–
R507	Blend	R125, R143A	–	✓	–
R404A	Blend	R134a, R125, R143A	–	✓	–

NOTES
1. HCFC – Hydrochlorofluorocarbon.
2. HFC – Hydrofluorocarbon.
3. In view of increasing world-wide restrictive legislation and phasing out of the refrigerants R12, R22 and R502, it is recommended that these refrigerants should not be used in any new installation.
4. Although ozone depleting and global warming potentials are not included in these Rules for classification, these effects are important and need to be considered when selecting the refrigerant for a particular application. In this respect attention is drawn to the *Provisional Rules for Environmental Protection*.

Table 3.2.1 Primary refrigerants and their class of pipe

Refrigerant	Type	Composition	Class I	Class of Pipe Class II	Class III
R-717 (Ammonia)	NH_3	—	✓	—	—
R-22	HCFC	—	—	✓	—
R-290 (Propane)	HC	—	—	✓	—
R-600a (Isobutane)	HC	—	—	✓	—
R-134a	HFC	—	—	—	✓
R-407C	Blend	R-32, R-125, R-134a	—	✓	—
R-410A	Blend	R-32, R-125	—	✓	—
R-507A	Blend	R-125, R-143a	—	✓	—
R-404A	Blend	R-134a, R-125, R-143a	—	✓	—
R-744 (Carbon Dioxide)	CO_2	—		*See* 2.5.6	

NOTES
1. HCFC – Hydrochlorofluorocarbon.
2. HFC – Hydrofluorocarbon.
3. HC – Hydrocarbon.
4. In view of increasing world-wide restrictive legislation and phasing out of the refrigerants R-22, it is recommended that this refrigerant should not be used in any new installation.
5. Although ozone depleting and global warming potentials are not included in these Rules for Classification, these effects are important and need to be considered when selecting the refrigerant for a particular application.

Table 3.2.2 Pressure limits

Refrigerant		Pressure (bar g)	
		High	Low
~~R717~~	R-717	21,2	17,2
~~R22~~	R-22	20,6	16,7
	R-290	18,1	14,7
	R-600a	6,4	5,2
~~R134a~~	R-134a	13,4	10,9
~~R407C~~	R-470C	23,5	19,0
	R-410A	34,5	28,0
~~R410B~~		~~33,0~~	~~26,8~~
~~R507~~		~~25,5~~	~~20,7~~
	R-507A	25,3	20,5
~~R404A~~		~~25,0~~	~~20,3~~
	R-404A	24,8	20,1
	R-744	*See* 2.5.6	

■ *Section 3*
Refrigerating machinery and refrigerant storage compartments

3.2 ~~Ventilation arrangements~~ Arrangements for compartments housing machinery using ammonia

3.2.1 Where ammonia refrigerant is used, the refrigerating machinery shall be installed in a dedicated gastight compartments. ~~is to be located as required by 3.1.2. The compartment is to comply with the requirements stated in 3.2.2 to 3.2.10. In the case of ammonia plants on fishing ships under 55 m overall length, or ammonia plants with a charge of ammonia not greater than 25 kg, the refrigerating machinery may be located in the main machinery space, *see* 3.2.11~~ *See also* 3.2.9.

3.2.3 The ventilation system is to ~~consist~~ be of the negative pressure type where abnormal stoppages of the extraction fans activate an audible and visual alarm ~~and a gas absorption unit~~.

~~*3.2.4* Abnormal stoppages of the fans or gas absorption unit are to activate audible and visual alarms~~.

~~*3.2.5* A gas absorption unit is to be provided to reduce ammonia vapour concentration to 20 ppm before its discharge to the atmosphere. The absorption unit is to:~~

- ~~have a column filled with packing compatible with ammonia and fitted with a spray chamber using sea-water. The capacity of the sea-water circulating pump is to be sufficient to maintain pressure and deliver the required amount of water to the scrubber. The circulating pump is to be started by activation of the ammonia high concentration level alarm;~~
- ~~have sufficient capacity to absorb at least the total charge of ammonia in the largest of the refrigerating units;~~
- ~~be provided with arrangements for acid injection to ensure the pH value does not fall below 10,5;~~
- ~~have a discharge pipe led from the unit to a water dump tank, *see* 3.2.6; and~~
- ~~have pipes, valves, nozzles and other fittings manufactured from materials resistant to corrosion by sea-water.~~

~~*3.2.6* A water dump tank is to be provided below the level of the refrigerating machinery space. The tank is to:~~

- ~~have sufficient capacity to hold 11 kg of water per kg of the ammonia charge of the largest refrigerating unit and be able to contain water equivalent to three hours of continuous scrubbing;~~
- ~~be provided with suitable water overflow and drainage arrangements not connected with the main machinery spaces. The overflow and drain pipes are to be fitted with stop valves;~~
- ~~have its internal surfaces protected against corrosion and chemical attack;~~
- ~~be provided with access arrangements for inspection and maintenance; and~~
- ~~have the air space above the level of the water connected to the refrigerating machinery compartment's ventilation system to extract any ammonia vapour.~~

~~*3.2.7* Special consideration will be given to the use of gaseous carbon dioxide as an alternative to a gas absorption unit together with a water dump tank for neutralizing escaping ammonia.~~

~~*3.2.8.*~~ *3.2.4* Compartments containing ammonia refrigerating machinery, including process vessels, are to be provided with:

- a negative ventilation system, independent of ventilation systems serving other spaces, having a capacity of not less than 30 air changes per hour based upon the total volume of the space. Other suitable arrangements which ensure an equivalent effectiveness may be considered;
- fresh air inlets, located at a low level in the machinery compartment and arranged so as to provide a supply of fresh air and to minimize the possibility of re-cycling the exhaust air from the outlet;
- exhaust outlets, located at a high level and arranged so as to promote good air distribution throughout the compartment;
- a fixed ammonia detector system with alarms inside and outside the compartment;
- water screens above all access doors, operable manually from outside the compartment in all ambient conditions;
- an independent bilge system
- ~~at least two access doors, opening outwards, one of which is to be an emergency exit giving direct access to open deck. The doors are to be fitted with an easily operated opening mechanism to facilitate rapid escape in an emergency; and~~
- ~~at least two sets of self-contained breathing apparatus and protective clothing.~~
- where the charge is greater than 50 kg, emergency body shower and eye wash facilities shall be installed locally outside the compartment. The water for the shower is to be thermostatically controlled so as to avoid low temperature shock.

3.2.5 Compartments are to have at least two access doors, opening outwards, one of which is to be an emergency exit giving direct access to the open deck. The doors are to be fitted with an easily operated opening mechanism to facilitate rapid escape in an emergency. In the case of small compartments where more than one door would be impractical, the emergency exit only is to be provided.

3.2.6 At least two sets of self-contained breathing apparatus and protective clothing are to be provided, readily available in the vicinity of the compartment but external to the area of risk. *See* 8.1.4.

~~*3.2.9*~~ *3.2.7* The location of the exhaust duct from the compartment or area is to be free from obstruction and be such as not to cause danger. Where practicable, ~~at least~~ they are to be 10 m, ~~where practicable~~, in the horizontal direction from other ventilation intakes and openings to accommodation and other enclosed areas, and at least 2 m above the surrounding deck.

~~*3.2.10*~~. *3.2.8* Ventilation fans are not to produce a source of vapour ignition in either the ventilated compartment/area or ventilation system. Ventilation fans and fan ducts, in way of fans only, are to be of non-sparking construction.

~~*3.2.11*~~ *3.2.9* In the case of ammonia plants on fishing ships under 55 m overall length, or ammonia plants with a charge of ammonia not greater than 25 kg, the refrigerating machinery may be located in the main machinery space provided it complies with the following requirements:

- The entrance to the machinery space is properly illuminated and marked and has warning signs permanently posted.
- The area where the ammonia machinery is installed is served by a hood with a negative ventilation system, so as not to permit any leakage of ammonia dissipating into other areas.
- A water spray system is provided for the area.
- Coamings, of not less than 150 mm in height, are installed around the ammonia machinery area.
- A fixed ammonia detector system with alarms inside and outside the main machinery space is provided.
- Means are provided for stopping the ammonia compressor prime movers from a position outside the machinery space.
- At least two sets of self-contained breathing apparatus and protective clothing are ~~made available~~. to be provided readily available in the vicinity of the compartment but external to the area of risk. *See* 8.1.4.
- ~~Portable gas analyzers are made available for sampling the atmosphere in the machinery space.~~

- Air intakes of other machinery are located away from the ammonia machinery area as far as is practicable.

3.3 Gas storage compartments

3.3.3 Bulk storage tanks holding more than 150 kg of replacement carbon dioxide are to be located in a separate compartment. The compartment is to be provided with a mechanical ventilation system having a minimum capacity of 6 air changes per hour. The ventilation system exhaust ducting is to remove air from the base of the compartment. The compartment is to be fitted with a gas tight access door opening outward.

Existing paragraphs 3.3.3 *to* 3.3.6 *have been renumbered* 3.3.4 *to* 3.3.7.

3.4 Compartments housing carbon dioxide containing equipment

3.4.1 Self closing gas tight access doors are to be provided between each compartment and the dedicated escape routes. *See* 5.1.5.

3.4.2 In compartments which are normally occupied and where the volume of ventilation required by 3.1.3 is not desirable, such as production areas on fishing vessels, a negative pressure ventilation system, capable of 10 air changes per hour, is required to be fitted. This ventilation system is to be automatically activated when, in the event of a leak the concentration of carbon dioxide reaches a predetermined level but in no case higher than the threshold limit value of 5,000 ppm.

■ *Section 4*
Refrigeration plant, pipes, valves and fittings

4.1 General requirements for refrigerating compressors

4.1.10 Where any hermetic or semi-hermetic compressor has the electric motor cooled by the circulating refrigerant, the following arrangements are to be provided:

(a) Refrigeration circuits are to contain no more than one hermetic or semi-hermetic compressor.

(b) Every compressor motor is to be fitted with a thermal cut-out device to protect the motor against overheating.

(c) In each refrigeration circuit containing a hermetic or semi-hermetic compressor, suitable arrangements shall be provided to remove debris and contaminants resulting from a motor failure. *See* 4.16.1.

(d) The pressure envelope of any hermetic or semi-hermetic compressor exposed to the refrigerant pressure is to be designed and constructed in accordance with the requirements of Pt 5, Ch 11 and Ch 17 as applicable. Plans are to be submitted for consideration as required by Pt 5, Ch 11,1.6.

4.11 Piping systems

4.11.2 Pipework for Ammonia ~~(R717)~~ (R-717) is to comply with Class 1 requirements.

4.11.6 Copper piping is to be manufactured in accordance with Pt 5, Ch 12,3 except in the case of small air coolers having finned pipes of sizes not greater than 19 mm outside diameter, and which have been fabricated under workshop conditions. The finned pipes may have a minimum wall thickness of 0,5 mm when used with ~~R22~~ R-22 and ~~R134a~~ R-134a refrigerants.

4.15 Overpressure protection devices

4.15.3 Relief discharge is to be led to a safe place above deck away from personnel accesses and air intakes. Discharge piping should be designed to preclude ingress of water, dirt or debris which may cause the equipment to malfunction.

4.15.7 Each compressor is to be provided with automatic shutdown in the event of high discharge pressure~~,~~. For refrigeration systems where the maximum working pressure is less than or equal to 40 bar g the automatic shutdown ~~which~~ is to operate at a pressure in excess of normal operating pressure but no greater than 0,9 of the maximum working pressure. For refrigeration systems where the maximum working pressure is greater than 40 bar g the automatic shutdown is to operate at a pressure in excess of normal operating pressure but no greater than 0,95 of the maximum working pressure.

4.15.10 Omission of one of the specified relief devices and the changeover device, as required by 4.15.8, will be allowed where:

- vessels are of less than 300 litres internal gross volume; or
- vessels discharge into the low pressure side by means of a relief valve; or
- vessels operating using only cargo gas and, which can be independently isolated and gas freed during normal cargo operations provided that a shelf spare is carried.

4.15.17 The minimum required discharge capacity related to air of the pressure relief device for each pressure vessel is to be determined as follows:

$$C = D\,L\,f$$

where

C = minimum required discharge capacity related to air of each relief device, in kg/s

D = outside diameter of the vessel, in metres

L = length of the vessel, in metres

f = factor which is dependent on the refrigerant:

~~R717~~ R-717 (Ammonia)	0,041
~~R-22~~ R-22, ~~R-134a~~ R-134a, R-407C	0,131
~~R404A~~	~~0,180~~
~~R407C~~	~~0,131~~
~~R410B~~	~~0,197~~
R-290 (Propane), R-600a (Isobutane)	0.082
R-410A, R-404A, R-507A	0,203
R-744 (Carbon dioxide) (when used on the low side of a cascade system)	0,082

4.15.18 The rated discharge capacity of the pressure relief valves expressed in kg/s of air may also be determined in accordance with an appropriate recognised National or International Standards such as *ISO 5149 Mechanical Refrigeration Systems used for Cooling and Heating – Safety Requirements.*

4.15.22 As carbon dioxide can form a solid powder at atmospheric pressure, there is a possibility that relief devices will choke if vented directly to atmosphere. The method used to guard against the formation of powder is to be submitted for consideration.

4.15.23 In carbon dioxide systems, overpressure protection is to be fitted to pipelines or components which can be isolated in a liquid full condition. Pressure relief devices are to be arranged such as to vent vapour at all times.

4.15.24 In cascade systems where carbon dioxide is used in combination with ammonia, the effects of carbon dioxide leaking into the ammonia side are to be considered. It may be desirable to design the ammonia system to either withstand the design pressure on the carbon dioxide side or have relief arrangements to safely deal with the additional vapour produced if a leak occurs.

4.16 Filters, driers and moisture indicators

4.16.2 Refrigerant filters, driers and moisture indicators are to be fitted in ~~R22 and R134a~~ halocarbon refrigerant systems, and the arrangement is to be such that filters and driers can be by-passed, isolated and opened up without interrupting plant operations.

■ *Section 5*
Refrigerant detection systems

5.1 General

5.1.5 For carbon dioxide systems, spaces such as machinery rooms, storage compartments, production areas on fishing vessels and valve stations, where leakage may occur, are to be fitted with detectors. Welded pipelines passing through passageways or access ducts are not considered possible leakage areas.

5.1.6 Audible and visual alarms are to be activated, located both inside and outside the affected space. The alarms are to be readily identifiable and be visible and audible in all locations within the space housing the refrigeration equipment.

5.2 Ammonia vapour detection and alarm equipment

5.2.1 A fixed detector system for ammonia is to comply with the requirements contained in 5.1.2. ~~5.2.2 to 5.2.6. The alarm indication is to be both inside and outside the compartment.~~

5.2.3 Ammonia vapour detectors are to be provided in the refrigeration machinery compartment, associated access ways, the exhaust ducts ~~from the gas absorption unit~~, the ammonia store room and the discharge pipes from pressure relief valves.

5.2.4 ~~A detector will normally cover an area of 36 m^2.~~ Sufficient detectors are to be provided to monitor the total areas of the above spaces.

~~*5.2.5* An ammonia vapour detector is to be fitted in the exhaust duct from the gas absorption unit to activate an audible and visual alarm in the control room if the concentration of ammonia exceeds 25 ppm by volume. For vapour detection in relief valve discharge pipes, *see* 4.15.4.~~

5.2.5 For vapour detection in relief valve discharge pipes, *see* 4.15.4.

~~*5.2.6* The detectors are to stop the ammonia refrigerating plant, activate the booster fans and audible and visual alarms if the concentration of ammonia exceeds 400 ppm by volume.~~

5.2.6 Details of the refrigerant detector set points and operational philosophy are to be submitted for consideration.

■ *Section 8*
Personnel safety equipment and systems

8.1 Personnel safety equipment

8.1.4 Where ammonia is used in refrigerating systems, the following items of safety equipment are to be provided as a minimum, and positioned in accessible protected storage (e.g. locked glass fronted cabinets) located outside the machinery compartment:

- Two sets of ammonia protective clothing (including helmet, boots and gloves).
- Two portable battery powered hand lamps (to be of certified safe-type).
- Two sets of self-contained breathing apparatus (compressed air) ~~each of which is to incorporate effective means of radio communication (to be of a certified safe-type).~~
- Two full face mask respirators.
- Two fire-resistant life-lines.
- Two firemen's axes.
- Two heavy duty adjustable spanners.
- Two wheel wrenches.
- Irrigation facilities or eye wash bottles containing an eye wash solution, distilled water or non-carbonated mineral water.
- Hand or foot-operated douches providing a copious supply of clean water, located outside the compartment's doors. *See* 3.2.4.

■ *Section 9*
Refrigerated cargo spaces

9.2 Insulation systems

~~*9.2.2* Insulating materials and panels are to be of a type that has been approved by LR. Prefabricated panels, with an organic foam core and metal or similar cladding both sides, are also to be manufactured under survey at a works approved by LR. Organic foam materials are to be certified as self-extinguishing. All materials are to be free from odour likely to cause taint.~~

9.2.2 *In situ* insulation and insulating panels are to be of a type that has been approved by LR and accordingly, whenever practicable, be selected from the *List of Type Approved Products* published by LR. A copy of the *Procedure for LR Type Approval System* will be supplied on application. Prefabricated panels, with an organic foam core and metal or similar cladding both sides, are also to be manufactured under survey at a works approved by LR. Organic foam materials are to be certified as self-extinguishing. All materials are to be free from odour likely to cause taint.

Part 7, Chapter 4
Dynamic Positioning Systems

Effective date 1 July 2007

■ *Section 2*
Class notation DP(CM)

2.3 Electrical systems

2.3.10 Any loads that require an uninterrupted electrical power supply are to be provided with uninterruptible power systems (UPS) ~~systems~~ having a capacity for a minimum of 30 minutes' operation following loss of the main supply.

Part 7, Chapter 9
Navigation Arrangements for Periodic One Man Watch

Effective date 1 July 2007

■ *Section 1*
General requirements

1.2 Information and plans required to be submitted

1.2.1 The following information and plans are to be submitted in triplicate:

- Details of the intended area of operation of the ship.
- List of navigational equipment detailing manufacturer, and model and National Authority approval (where applicable).
- Functional block diagrams and descriptions of the navigational equipment, internal communications systems and watch safety system indicating their relationship to each other.
- Details of the electrical power supplies to the navigational equipment, internal communications systems, watch safety system, and clear view arrangements.
- A general arrangement of the ship showing the fields of vision from the bridge.
- A general arrangement of the bridge and wheelhouse showing the positions of consoles, panels, handrails, seating, windows and clear view arrangements.
- A profile view of the wheelhouse detailing the inclination of windows, heights of upper and lower edges of windows, and dimensions of consoles.
- Detailed arrangements of consoles and panels showing the layout of equipment.
- Test schedules which should include methods of testing and test facilities provided.
- A schedule of the electrical and electronic equipment referred to in 2.2.10 giving details of:
  - equipment description;
  - manufacturer;
  - type and/or model; and
  - Evidence of electromagnetic compatibility.

■ *Section 2*
Physical conditions

2.2 Environment

2.2.9 Permanently installed electrical and electronic equipment is to be installed so that electromagnetic interference does not affect the proper function of the navigational systems and equipment. Installation of the equipment in accordance with the guidelines and recommendations included in IEC 60533: *Electrical and electronic installations in ships – Electromagnetic compatibility*, or an acceptable equivalent standard, would generally be considered to meet the requirement.

2.2.10 Permanently installed electrical and electronic equipment, on the bridge and in the vicinity of the bridge, that is not subject to the approval required by 3.1.12, is to have undergone electromagnetic compatibility testing that demonstrates the equipment satisfies the conducted and radiated emission requirements of:

- IEC 60533: *Electrical and electronic installations in ships – Electromagnetic compatibility; or*
- IEC 60945: *Maritime navigation and radio communication equipment and systems – General requirements – Methods of testing and required test results.*

Testing in accordance with other appropriate standards is subject to consideration and details are to be submitted.

2.2.11 To demonstrate compliance with 2.2.10, a schedule of applicable equipment is to be compiled, *see* 1.2.1. Where it is proposed to add to or modify the equipment referred to in 2.2.10 the schedule is to be maintained accordingly, *see also* 6.1.1. A copy of the schedule documentation is to be placed on board the vessel and a copy is to be made available to the LR Surveyor on request.

2.2.12 Passive electromagnetic equipment, considered not liable to cause or be susceptible to electromagnetic disturbances, may be provided with an exemption statement in place of evidence of electromagnetic compatibility for the purposes of 2.2.11. Examples of passive electromagnetic equipment include cables, purely resistive loads and batteries.

2.4 Windows

2.4.2 Windows are to be as wide as possible and divisions between them are to be kept to a minimum. No division is to be positioned immediately forward of any workstation or on the ship's centreline.

■ *Section 3*
Workstations

3.1 Navigation workstation

(*Part only shown*)

3.1.4 The following facilities are to be provided at the navigation workstation:

- Speed and distance indications, *see* ~~3.1.10~~ 3.1.11 and ~~3.1.11~~ 3.1.12.
- Course/track controls and indications, *see* 3.1.8 ~~and 3.1.9~~ to 3.1.10.

3.1.7 A gyrocompass or alternative means for determining, displaying and transmitting the ship's heading by shipborne, nonmagnetic means, is to be provided and is to be clearly readable by the helmsman at the main steering position. The heading information is to be used directly by the radars, radar plotting aids and automatic identification system, see 3.1.5 and ~~3.1.12~~ 3.1.13. The gyrocompass is to be provided with a gyrocompass heading repeater located at the emergency steering position in the steering gear compartment and a gyrocompass bearing repeater allowing bearings to be taken over 360°.

3.1.9 Heading monitoring is to be provided to monitor the actual heading information by independent heading sources. An off-course warning is to be given if the actual heading of the ship deviates from the track course beyond a pre-set value. The pre-set off-course warning limit is to be large enough to prevent unnecessary alarms.

Existing paragraphs 3.1.9 *to* 3.1.13 *have been renumbered* 3.1.10 *to* 3.1.14.

~~*3.1.14* Electrical and electronic equipment shall be installed so that electromagnetic interference does not affect the proper function of the navigational systems and equipment. Installation of the equipment in accordance with the guidelines and recommendations included in IEC 60533 *Electrical and electronic installations in ships – Electromagnetic compatibility* or an acceptable equivalent standard would generally be considered to meet the requirement.~~

■ *Section 5*
Integrated Bridge Navigation System – IBS notation

5.3 Equipment

5.3.2 Only one gyrocompass is to be used by the integrated bridge system at any time for main display and control purposes. The navigating officer is to be able to switch between compasses at any time. ~~and the~~ The non-selected compass is to be used automatically as the independent heading source for the off-course warning required by ~~3.1.8~~ 3.1.9.

5.3.13 The following alarms are to be provided and included in the centralized alarm system specified by 4.1.1:

- Off-track~~, see 3.1.8~~.
- Waypoint approaching, *see* ~~3.1.9~~ 3.1.10.
- Position fix inaccurate/lost.
- Loss of heading input.
- Loss of log input.
- Equipment or sub-system failure.
- Gyro mis-match.

Part 7, Chapter 11
Arrangements and Equiptment for Environmental Protection

CORRIGENDA

■ *Section 2*
Environmental Protection (EP) class notation

2.6 Oil pollution prevention

2.6.6 Leakages and waste oil from machinery and equipment are to be collected in a dedicated waste oil tank prior to disposal ashore or incineration. This waste oil tank is to be separate from the sludge tank specified in MARPOL Annex I, Regulation ~~17~~ 2. The volume of the waste oil tank is to be of sufficient capacity to hold a complete lubricating oil charge from the largest engine used for propulsion or electrical generating purposes.

2.6.9 Discharge piping systems to deck from the bilge holding tank, and the waste oil tank, are to be separate from the oil fuel loading and transfer systems. The bilge holding tank and waste oil tank piping systems are to be terminated with the standard discharge connections specified in MARPOL Annex I, Regulation ~~19~~ 13. The sludge tank may be discharged through the same piping system as the waste oil tank.

2.6.12 The constructional requirements of MARPOL Annex I, ~~Regulation 13F and 13G~~ Regulations 19 and 20 as applicable, are to apply to all oil tankers greater than 600 tonnes deadweight.

■ *Section 3*
Supplementary characters

3.2 Ballast water management – B character

3.2.2 The ballast water management plan is to ~~take account of the safety considerations detailed in IMO Resolution A.868(20)~~ be developed in accordance with IMO Resolution MEPC 127(53) and take note of the safety considerations in IMO Resolution MEPC 124(53).

3.2.3 For new ships, the guidance within IMO Resolutions MEPC 149(55) and MEPC 150(55) is to be taken account of, as far as is practicable.

3.6 Protected oil tanks – P character

3.6.2 The location of tanks is to be in accordance with the requirements ~~of MARPOL Annex I, Regulation 12A~~ relating to oil fuel tank protection given in IMO Resolution MEPC. 141(54).

Part 7, Chapter 12
Integrated Fire Protection (IFP) Systems

Effective date 1 July 2007

■ *Section 1*
General

1.2 Submission of plans and information

1.2.1 The following plans and information are to be submitted:

- A plan showing the location and physical arrangement of the centralized fire-control station.
- A list of systems and equipment that are to be controlled and monitored from the centralized fire-control station, *see* 1.2.2.
- Details of controls, alarms, instrumentation and monitoring including line diagrams of control circuits, descriptions of operation and programmable electronic systems details required by Pt 6, Ch 1,1.2.5.
- Details of the power supply arrangements.
- Remote stopping arrangements for independently driven oil pumps and remote oil valve closing arrangements.
- Test schedules including methods of testing and required test results.
- Failure Mode and Effects Analysis (FMEA) report, including worksheets.

■ *Section 2*
Centralized fire-control station

2.2 Communication

2.2.1 At the centralized fire-control station, fixed means of two-way speech communication is to be provided to all the accommodation and service spaces and other control stations, including the main machinery control station and bridge, if applicable. This means of communication is to be independent of the main source of electrical power.

2.2.2 In addition to the communication required by 2.2.1, a public address system is to be provided that is clearly audible throughout the accommodation and service spaces and other control stations, including the main machinery control station and navigating bridge, if applicable. The public address system is to be operable from the centralized fire-control station and comply with Pt 6, Ch 2,17.3

■ *Section 3*
Control and monitoring of active fire protection and fixed fire-extinguishing systems

3.1 General

3.1.5 A Failure Mode and Effects Analysis (*see* Pt 6, Ch 1,2.12.5) is to be carried out, which is to demonstrate that:

(a) failure of any part of the Integrated Fire Protection system will not result in a loss or degradation of centralized control and monitoring functions for more than one active fire protection or fixed fire-extinguishing system,

(b) failure of any active fire protection or fixed fire-extinguishing system will not result in the loss or degradation of another system as a result of their interconnection through the Integrated Fire Protection system, and

(c) any such failures are evident at the centralized fire-control station, by means of audible and visual alarms.

NOTE:
The FMEA is to be carried out to the level of identifiable hardware and software component parts providing defined functions, e.g. display unit, network interface card, etc. and is to consider the effects of:

(i) random failures of hardware components, and,

(ii) common mode failures of hardware and software components, unless these components have been ertified for use in safety applications, *see* Pt 6, Ch 1,2.

3.3 Fixed water-based fire-extinguishing systems, including local application systems

3.3.2 Controls are to be provided for the following:

- The starting and stopping of all fire pumps.
- The opening and closing of all sea valves serving the fire pumps.
- The opening and closing of all system(s) isolating valves and distribution control valves for water and foam solution.
- The effective operation of foam monitors. Where a clear view of foam monitor nozzles is not available from the ~~integrated~~ centralized fire-control station, television surveillance or other suitable means for observing the monitors may be accepted.

Part 7, Chapter 14
Passenger and Crew Accommodation Comfort

Effective date 1 July 2007

■ *Section 1*
General requirements

1.1 Scope

1.1.1 These Rules set down the criteria for the assessment of the noise and vibration on ships and are applied in addition to the other relevant requirements of the *Rules and Regulations for the Classification of Ships* (hereinafter referred to as the Rules for Ships).

1.1.2 Compliance with these Rules is optional.

1.1.3 These Rules provide for two alternatives:
(a) **Class Notations** which indicate that the ship has been assessed and complies with noise and vibration criteria in these Rules and that a periodic survey regime has been established for the lifetime of the ship.
(b) **Certificate of Compliance** which provides evidence that the ship has been assessed and found to comply with the noise and vibration criteria in these Rules.

1.1.4 These Rules recognize existing National and International Standards and specify levels of noise and vibration currently achievable using good engineering practice. Compliance with these requirements will be assessed by review of procedures, inspection and measurement of the relevant parameters and pre-survey reviews. Inspections and measurements are to be conducted, witnessed or assessed by LR's Surveyors unless otherwise agreed by Lloyd's Register (hereinafter referred to as LR).

1.1.5 Accommodation comfort is a function of ship type and layout. These Rules address two types of ship:
(a) Passenger (e.g. cruise ships, ro-ro ferries).
(b) Cargo (e.g. container ships, tankers).

1.1.6 These Rules include levels of noise and vibration which should be verified by measurements following completion of the ship. It is recommended that the Builders undertake calculations of noise and vibration characteristics so that any potential problem areas can be identified and control measures implemented.

1.1.7 The sound pressure levels for audible alarms and public address systems fitted in accordance with other sections of the Rules are to satisfy IMO Resolution A.830(19) Code on Alarms and Indicators.

1.2 Definitions

1.2.1 **Passenger spaces** are defined as all areas intended for passenger use, and include the following:
(a) Passenger cabins.
(b) Public spaces (e.g. restaurants, hospital, lounges, reading and games rooms, gymnasiums, corridors, shops).
(c) Open deck recreation areas.

1.2.2 **Crew spaces** are defined as all areas intended for crew use only, and include the following:
(a) Accommodation spaces (e.g. cabins, offices, mess rooms, recreation rooms).
(b) Work spaces.
(c) Navigation spaces.

1.2.3 **Noise level** is defined as the A-weighted sound pressure level measured in accordance with ISO 2923.

1.2.4 **Vibration level** is defined by the application of either of the two versions of the ISO 6954 standard:
(a) Where ISO 6954:1984 is applied, the vibration level is defined as the single amplitude peak value of deck structure vibration during a period of steady state vibration, representative of maximum repetitive behaviour, in mm/s, over the frequency range 5 to 100 Hz. For frequencies below 5 Hz, the requirements for vibration levels follow constant acceleration curves corresponding to the acceleration at 5 Hz.
(b) Where ISO 6954:2000 is applied, the vibration level is defined as the overall frequency weighted r.m.s. value of vibration during a period of steady-state operation over the frequency range 1 to 80 Hz.

In general, ISO 6954-2000 is the preferred standard to be applied, however ISO 6954-1984 may be applied where there are practical difficulties in application of ISO 6954-2000 and this has been agreed between the Owner and Builder.

1.3 Class notations

1.3.1 The class notations described in 1.3.2 to 1.3.6 provide standards for noise and vibration levels in different spaces at the time of delivery and during the ships life if substantial changes to the machinery installation or interior arrangements are made.

1.3.2 The **PAC** (Passenger Accommodation Comfort), **CAC** (Crew Accommodation Comfort) and **PCAC** (Passenger and Crew Accommodation Comfort) notations are optional and are primarily intended to apply to passenger ships. If requested, however, any ship can be assessed for compliance, using these requirements as the basis for the assessment and a LR Certificate of Compliance issued (*see* 1.1.3(b) and 1.4).

1.3.3 The **PAC** notation indicates that the passenger accommodation meets the acceptance criteria whilst the **CAC** notation indicates that the crew accommodation and work areas meet the acceptance criteria. The **PCAC** notation indicates that the passenger and crew spaces both meet the acceptance criteria.

1.3.4 For ships which achieve the noise and vibration comfort standards specified in these Rules, the notation **PAC**, **CAC** or **PCAC** will be assigned.

1.3.5 Following the **PAC** or **CAC** notation, numerals **1**, **2** or **3** will indicate the acceptance criteria to which the noise and vibration levels have been assessed. In the case of the **PCAC** notation, two numerals will be assigned. The first will indicate the acceptance criteria for passenger accommodation, whilst the second will indicate the crew comfort criteria.

1.3.6 For particular vessels, impact insulation and transient noise in accordance with 2.5 and 2.6 together with any additional or more stringent noise and vibration criteria may be assessed within the scope of the notations where agreed between the Owner, Builder and LR.

1.4 Certificate of Compliance

1.4.1 A Certificate of Compliance records that a ship has been designed and constructed to satisfy the noise and vibration criteria contained in these Rules. This is to be confirmed by measurements and reporting in accordance with Sections 4 and 5.

1.4.2 A Certificate of Compliance is optional and if requested, any ship can be assessed for compliance using the Rule requirements as basis for assessment.

1.4.3 Where noise and vibration levels are at variance with those prescribed by these Rules, these will be added to the certificate for information purposes.

1.4.4 A Certificate of Compliance will be issued after the initial survey required by Section 6.

■ *Section 2* Noise

2.1 Assessment criteria

2.1.1 Where a space is occupied by both passengers and crew, the more stringent of the relevant requirements apply unless agreed between the Builder and Owner and advised to LR.

2.2 Passenger accommodation and public spaces

2.2.1 Under test conditions specified in 4.2, the applicable noise levels specified in Table 14.2.1 should not generally be exceeded. *See* 2.2.3.

2.2.2 For cabins bordering discotheques and similar entertainment areas, the deck and bulkhead sound insulation is to be sufficient to ensure that the maximum cabin noise levels are not exceeded even when high external noise levels prevail.

Table 14.2.1 Passenger ships – Maximum noise levels in dB(A)

Location		Acceptance Numeral		
		1	2	3
Passenger cabins:	Standard	49	52	55
	Superior	45	47	50
Public spaces:	Excluding shops	55	58	62
	Shops	60	62	65
Medical centre:		50	55	60
Theatre/auditorium		50	55	60
Open deck recreation areas (excluding swimming pools and similar)		67	72	72
Swimming pools and similar		70	75	75

NOTES
1. The levels may be exceeded by 5dB(A) within 3 m of a ventilation inlet/outlet or machinery intake/uptake on open decks.
2 The levels may be exceeded by 3dB(A) in accommodation above the propellers for three decks above the mooring deck.
3. The levels for open deck recreation areas refer to ship generated noise only. On open deck spaces the noise generated from the effects of wind and waves can be considered separately to limits agreed between the Builder and Owner and advised to LR for the trial conditions.

2.2.3 Acceptance of noise levels greater than those specified in Table 14.2.1 may be considered where agreed between the Owner and Builder. Not more than 20 per cent of the passenger cabins, 30 per cent of the public spaces and 20 per cent of the crew cabins should exceed the relevant noise criteria by more than 3 dB(A).

2.2.4 Acoustic insulation of bulkheads and decks between passenger spaces is to be generally in accordance with the values of the weighted apparent sound reduction index R_W as given in Table 14.2.2, calculated using ISO 717/1. *See also* 2.2.6.

2.2.5 For the purpose of selecting acoustic sound insulation, the following sound noise levels may be used with the agreement of the Owner and Builder:
(a) Cabins – 80 dB(A).
(b) Dining Rooms – 85 dB(A).
(c) Corridors – 90 dB(A).
(d) Discotheques, Theatres, Entertainment Areas – 105 dB(A).

2.2.6 Acceptance of bulkhead and deck acoustic insulation values less than those specified in Table 14.2.2 may be considered where agreed between the Owner and Builder. Not more than 20 per cent of the interfaces tested should have airborne sound insulation indices, R_W, more than 3 dB(A) lower than the minimum specified values.

Table 14.2.2 Minimum air-borne sound insulation indices, R_w

Location		Acceptance Numeral		
		1	2	3
Passenger cabins:	Standard Superior	40 45	38 42	37 40
Cabin to corridor:	Standard Superior	38 42	36 40	34 37
Cabin to stairway:	Standard Superior	47 50	45 47	43 45
Cabin to public space (excluding corridors/stairwells and discotheques):	Standard Superior	52 55	48 50	48 50
Discotheques to cabins		60	60	60
Discotheques to stairwells and public spaces		52	52	52
Cabin to machinery rooms and engine casing		55	53	50

2.3 Crew accommodation and work areas

2.3.1 Under the applicable test conditions specified in 4.2, the noise levels specified in Tables 14.2.3 and 14.2.4 are not to be exceeded.

2.3.2 Crew space insulation is to comply with the requirements of IMO Resolution A.468(XII).

Table 14.2.3 Crew accommodation – Maximum noise levels in dB(A)

Location	Acceptance Numeral		
	1	2	3
Sleeping cabins, hospitals	52	55	60
Day cabins	55	60	60
Office conference rooms	55	60	65
Mess rooms, lounges, reception areas:			
Within accomodation	57	60	65
On open decks	67	72	75
Alleyways, changing rooms, bathrooms, lockers	70	75	75
NOTE The levels may be exceeded by 5 dB(A) within 3 m of a ventilation inlet/outlet or machinery intake/uptake on open decks.			

Table 14.2.4 Crew work areas – maximum noise levels in dB(A)

Location	dB(A) level
Machinery space (continuously manned) e.g. stores	90
Machinery space (not continuously manned) e.g. pump, refrigeration, thrusters or fan rooms	110
Workshops	85
Machinery control rooms	75
Wheelhouse	65
Bridge wing, additional limits: • 250 Hz band • 500 Hz band	 68 63
Radio room	60
Galleys and pantries: • Equipment not working • Individual items at 1 metre	 75 85
Normally unoccupied spaces (e.g. holds, decks)	90
Ship's whistle, on bridge or forecastle	110

2.4 Maximum noise levels

2.4.1 Where the measured noise level exceeds the specified criterion by 3 dB(A), or contains subjectively annoying low frequency or tonal components, the noise rating (NR) number is to be established in accordance with the graph shown in Fig. 14.2.1. This is achieved by plotting the linear octave band levels on the graph; the NR number is that NR curve to which the highest plotted octave band level is anywhere tangent. The specified criterion may be considered satisfied if the NR number does not exceed the specified A-weighted value minus 5 dB(A).

2.4.2 Guidance on maximum acceptable sound pressure levels and noise exposure limits for crew spaces is given in IMO Resolution A.468(XII).

2.5 Impact insulation

2.5.1 Where agreed between the Owner, Builder and LR, enhanced criteria for noise levels recognising the effects of impact sound pressures may be applied in accordance with 2.5.2 to 2.5.5.

2.5.2 For passenger and crew cabins located below or adjacent to dance floors, stages, aerobics and gymnasium areas, jogging tracks or other areas where impact noise is generated, the normalised impact sound pressure level measured within the cabins is not to exceed 45 dB.

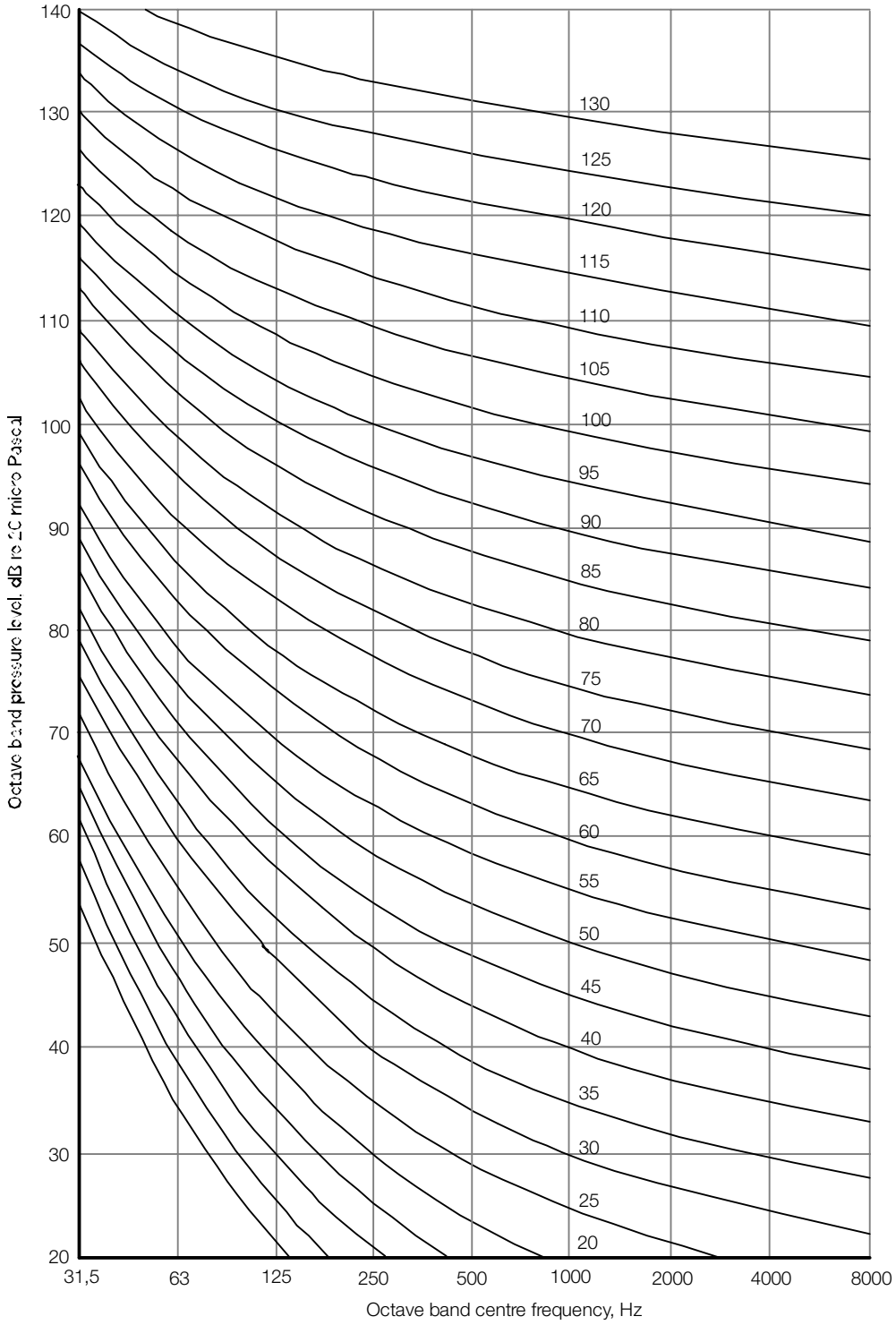


Fig. 14.2.1 Noise rating curves

2.5.3 For public rooms under dance floors, stages, aerobics and gymnasium areas, jogging tracks or other areas where impact noise is generated, the normalised impact sound pressure level within the space is not to exceed 55 dB.

2.5.4 For passenger cabins, the normalised impact sound pressure level, $L_{n,w}$, calculated using ISO 717/2, is to be generally in accordance with the values stated in Table 14.2.5. *See also* 2.5.5.

2.5.5 Acceptance of normalised impact sound pressure levels greater than those specified in Table 14.2.5 may be considered for assignment of the applicable class notation where agreed between the Owner, Builder and LR. No more than 20 per cent of the passenger cabins tested should exceed the levels specified by more than 3 dB.

Table 14.2.5 Passenger cabins normalized impact maximum sound pressure level $L_{n,w}$

Location	dB
Below decks covered with carpet and soft materials	50
Below decks covered in hard materials (such as wood, marble or similar)	60
Below dance floors, theatre or sports rooms	47

2.6 Transient noise

2.6.1 Where agreed between the Owner, Builder and LR, enhanced criteria for transient noise levels may be applied in accordance with 2.6.2.

2.6.2 The maximum sound pressure level (L_{max}) emanating from any machinery or system caused by a single event that produces a noise 'spike' compared to the reference condition sound level (such as vacuum systems or valve operations) is not to cause an increase in noise in comparison with the reference condition as below:

(a) Passenger cabins and public areas: +2 dB(A)
(b) Officer cabins: +2 dB(A)
(c) Crew cabins and public areas: +3 dB(A)

A tolerance of +1 dB(A) may be applied to 5 per cent of cabins and public areas in each fire zone on each deck. This criterion is generally applicable to the specified maximum noise levels for the space concerned.

■ *Section 3* Vibration

3.1 Assessment criteria

3.1.1 Where a space is occupied by both passengers and crew, the more stringent of the relevant requirements apply unless agreed between the Builder and Owner and this agreement advised to LR.

3.1.2 The limits apply to vertical, fore and aft and athwartship vibrations which are to be assessed separately.

3.1.3 Under test conditions specified in 4.2, the applicable vibration levels specified in Tables 14.3.1 and 14.3.2 should not be exceeded.

3.1.4 Acceptance of vibration levels greater than those specified in Tables 14.3.1 and 14.3.2 may be considered for assignment of the applicable class notation where agreed between the Owner, Builder and LR.

Table 14.3.1 Passenger ship – Maximum vibration levels

Standard	ISO 6954:1984			ISO 6954:2000		
Units:	Peak velocity (5–100 Hz)			Peak velocity (5–80 Hz) velocity mm/s rms		
	Acceptance Numeral					
Location	1	2	3	1	2	3
Passenger cabin Luxury	1,5	2,0	2,5	1,5	1,8	2,1
Passenger cabin Standard	1,5	2,5	4,0	1,8	2,1	2,4
Public spaces	1,5	2,5	4,0	2,0	2,5	3,0
Open recreation decks	2,5	3,5	5,0	2,5	3,0	3,5
NOTE The vibration level may be exceeded by 0,3 mm/s in the ship's aft body directly above the propellers.						

Table 14.3.2 Crew spaces – Maximum vibration levels

Standard:	ISO 6954:1984	ISO 6954:2000
Units:	Peak velocity (5–100 Hz)	Frequency weighted (1–80 Hz) velocity mm/s rms
Location		
Accommodation and navigation spaces	5,0	3,5
Work spaces	6,0	5,0

3.1.5 The vibration levels for ISO 6954:1984 are stated as peak vibration velocity amplitude. If root mean square levels are measured, each frequency component may be converted to peak vibration velocity amplitude by application of a 1.41 multiplication factor where the ISO 6954:1984 is used for assessment against Tables 14.3.1 and 14.3.2. An approximation of maximum repetitive values may be obtained for direct comparison with the graph in ISO 6954-1984 by further application of the 1,8 conversion factor as stated in the 'Interim guidelines' note of the standard.

3.2 Passenger accommodation and public spaces

3.2.1 Passenger spaces are to comply with the overall vibration levels specified in Tables 14.3.1 and 14.3.2.

3.2.2 No more than 20 per cent of all passenger spaces/areas and public spaces should exceed the relevant vibration criteria specified in Tables 14.3.1 and 14.3.2 by more than 0,3 mm/s whether using ISO 6954:2000 or ISO 6954:1984.

3.3 Crew accommodation and work spaces

3.3.1 Crew spaces are to comply with the overall vibration levels specified in Table 14.3.2.

■ *Section 4*
Testing

4.1 Measurement procedures

4.1.1 These requirements take precedence where quoted standards may differ.

4.1.2 The trial measurements may be undertaken by an approved technical organisation as defined in 4.7 or by LR. In the former case, the measurements are to be witnessed by a LR Surveyor.

4.1.3 Subject to agreement by LR and the Owner/ Operator, the measurements may be undertaken by the Builder. In this case, the measurements are to be witnessed by a LR Surveyor.

4.2 Test conditions

4.2.1 Test conditions for the surveys are to be in accordance with those detailed in ISO 2923 and ISO 6954:1984 or ISO 6954:2000 as applicable.

4.2.2 The intended operating and loading conditions of the ship during assessment surveys are to be submitted to LR for agreement, prior to commencement of surveys.

4.2.3 Surveys are to be conducted when the ship is fully outfitted and all systems contributing to noise and vibration levels are operational.

NOTE

All systems operational are to include those systems that may operate simultaneously with others during normal ship operation.

4.2.4 The test conditions required for the vibration and noise measurements are to be in accordance with the following conditions:

(a) For passenger ships, prior to measurement surveys being carried out, the ship operating condition where the worst conditions are experienced between 0 and 85 per cent maximum continuous rating of the propulsion machinery is to be determined. To establish this condition, four measurement positions are to be defined with the agreement of LR and measurements taken of the parameters of interest at ship speeds corresponding to percentages of the maximum continuous rating of the propulsion machinery increasing up to 40 per cent MCR in 10 per cent intervals and from 40 per cent in 5 per cent intervals up to the 85 per cent maximum continuous rating of the propulsion machinery. If the 85 per cent maximum continuous rating condition is found to be the worst condition, then this will form the trial operating conditions. However, if a lower speed condition is found to be worse than the 85 per cent maximum continuous rating condition then both that condition and the 85 per cent maximum continuous rating condition will form the trial operating conditions. Where unavoidable any barred range within the values required for the trial operating condition may be excluded on agreement between Owner and Builder subject to approval by LR.

(b) The power absorbed by the propeller(s) is to be that defined in 4.2.4(a). Alternatively, by special agreement, some lesser power could be accepted if it can be demonstrated by the Owner that this would correspond to a more representative normal service condition.

(c) Auxiliary machinery essential for the ship's operating conditions together with HVAC systems are to be running at their normal rated capacity during the noise and vibration trials. Combinations of auxiliary machinery operation may be necessary. In addition, the following equipment is to be running if appropriate: stabilizers, waste treatment equipment, swimming pool and jacuzzi equipment.

(d) For sea-going ships, measurements are to be taken with the ship proceeding ahead, at a constant speed and course, in a depth of water not less than five times the draught of the ship. For other ships, an appropriate water depth is to be agreed with LR prior to the trials.

(e) Trials are to be conducted in sea conditions not greater than sea state 3 on the WMO sea state code. In addition, noise measurements should not be taken when the wind force exceeds 4 on the Beaufort scale.

(f) The ship is to be at a displacement and trim representative of an operating condition.

(g) Rudder angle variations are to be limited to ±2° of the midship position and rudder movements are to be kept to a minimum throughout the measurement periods.

(h) In addition, for ships which are designed to spend a considerable period of time in harbour, the noise and vibration, are to be measured for this condition, with the auxiliary machinery and HVAC systems running at their normal rated capacity.

(j) For passenger ships, intermittently run equipment such as transverse propulsion units are to be operated at 60 per cent of their rated power for additional measurements in surrounding ship areas.

4.2.5 Prior to survey, a test programme is to be submitted for approval by LR. This programme is to contain details of the following:

(a) Measurement locations indicated on a general arrangement of the ship.

(b) The ship's loading condition during survey.

(c) The machinery operating condition, including HVAC system, during survey.

(d) Noise and vibration measuring equipment.

4.3 Noise measurements

4.3.1 Noise measurements are to be conducted in accordance with ISO 2923 and IMO Resolution A.468(XII). Measurements of noise levels are to be carried out using precision grade sound level meters conforming to IEC 60651, Type 1 or 2. Subject to demonstration, equivalent standards are acceptable.

4.3.2 Where the measured noise level exceeds the relevant criterion by 3 dB(A), or contains subjectively annoying low frequency noise or obvious tonal components, octave band readings are to be taken, with centre frequencies from 31,5 Hz to 8 kHz.

4.3.3 When outfitting is complete, and all soft furnishings are in place, sound insulation indices for passenger spaces are to be determined in accordance with ISO 140. Cabin to cabin indices are to be determined from a minimum of three locations within the passenger accommodation, the number of test locations being agreed with LR.

4.3.4 If required, impact sound measurements are to be carried out in accordance with ISO 140/7 and presented in accordance with ISO 717/2. *See* 4.4.4.

4.4 Noise measurement locations

4.4.1 Measurement locations are to be chosen so that the assessment represents the overall noise environment on board the ship. In addition to the requirements of IMO Resolution A.468(XII) for crew spaces, all public spaces and at least 50 per cent of passenger cabins in the after third of the ship, and 25 per cent elsewhere, are to be surveyed. Distribution of the measurement locations is to be agreed by LR.

4.4.2 During measurement trials, recognized noise sources are to be operated at their normal level of noise output (e.g. machinery at design rating).

4.4.3 In larger sized spaces, where noise levels may vary considerably, such as restaurants, lounges, atria and open deck recreation areas, measurements are to be taken at locations not greater than 7 m apart.

4.4.4 The number of and locations for impact noise measurements are to be agreed between the Builder, Owner and LR. The measurements are to be carried out when the ship is in harbour. The number and location of measurements are to take account of all different combinations of construction, areas of application, types of cabin and spaces below.

4.5 Vibration measurements

4.5.1 Vibration measurements are to be conducted in accordance with ISO 6954:1984 or ISO 6954:2000.

4.5.2 Measurements are to be made with instrumentation meeting the requirements of ISO 8041.

4.5.3 Vibration levels are to be given in terms of the velocity measurement appropriate to the version of the standard being used and should be measured over a period of not less than one minute.

4.6 Vibration measurement locations

4.6.1 Measurement locations are to be chosen so that the assessment represents the overall vibration environment onboard the ship. To minimize survey times, readings may be taken at the locations previously defined for the noise assessment part of the survey.

4.6.2 In cabins, vibration readings are to be taken in the centre of the floor area. The measurements are to indicate the vibration of the deck structure. In large spaces, such as restaurants, sufficient measurements are required to define the vibration profile.

4.6.3 Where deck coverings make transducer attachment impracticable, use of a small steel plate having a mass of at least 1 kg, with spikes as appropriate, is permissible.

4.6.4 At all locations, vibrations in the vertical direction are to be assessed. Sufficient measurements in the athwartships and fore and aft directions are to be taken to define global deck vibrations.

4.7 Approved technical organisation

4.7.1 An approved technical organisation for the purposes of these Rules is one that is acceptable to the Owner and LR with proven capability in noise and vibration measurement and satisfies all the criteria set out below:

(a) Have instrumentation whose calibration, both before and after the measurements, can be traced back to National Standards and, hence, back to International Standards.
(b) Have analysis procedures capable of data reduction to the requirements and standards set out in these Rules.
(c) Be able to provide a written report in English with contents as defined by Section 5.

■ *Section 5* Noise and vibration survey reporting

5.1 General

5.1.1 Prior to survey, a noise and vibration measurement plan is to be agreed by the Owner, Builder and LR.

5.1.2 The survey report is to comprise the data and analysis for both noise and vibration and is to be submitted to LR for consideration.

5.1.3 The survey report is to be prepared by the organisation undertaking the trial measurements, which may be an approved technical organisation or LR.

5.1.4 The survey report is to be submitted to LR's London Office (MCS/TID) for evaluation and confirmation that the results are in accordance with the noise and vibration levels specified in these Rules and/or agreed between the Owner and Builder. The assignment of a Class Notation or the issue of a Statement of Compliance will be subject to confirmation by LR MCS/TID.

5.2 Noise

5.2.1 The reporting of results is to comply with ISO 2923, and is to include:

(a) Measurement locations indicated on a general arrangement plan including, where possible, the measured dB(A) level.

(b) Tabulated dB(A) noise levels, together with octave band analysis for positions where the level exceeds the specified criterion by 3 dB(A), or where subjectively annoying low frequency or tonal components were present. The Noise Rating number is also to be given where octave band analyses have been conducted.

(c) Ship and machinery details.

(d) Trial details:
- Loading condition.
- Machinery operating condition.
- Speed.
- Average water depth under keel.
- Weather conditions.
- Sea state.

(e) Details of measuring and analysis equipment (e.g. manufacturer, type and serial numbers), including frequency analysis parameters (e.g. resolution, averaging time, window function).

(f) Copies of the relevant instrument calibration certificates, together with the results of field calibration checks.

5.3 Vibration

5.3.1 The report is to contain the following information:

(a) Measurement positions indicated on a general arrangement plan.

(b) Where ISO 6964:2000 is used, the frequency-weighted overall r.m.s. vibration levels tabulated for all measurement locations calculated using the weighting functions and methodology stated in the standard.

(c) Where ISO 6954:1984 is used, the maximum peak vibration levels and their corresponding frequencies taken from the frequency spectra, tabulated for all measurement locations.

(d) Ship and machinery details.

(e) Trial details:
- Loading condition.
- Machinery operating condition.
- Speed.
- Average water depth under keel.
- Weather conditions.
- Sea state.

(f) Frequency analysis parameters (e.g. resolution, averaging time and window function), if the analysis is done in the frequency domain.

(g) Copies of the relevant instrument calibration certificates, together with the results of field calibration.

■ *Section 6*
Non-periodical survey requirements

6.1 Class notation assignment

6.1.1 Where the assignment of a Class Notation or a Statement of Compliance is requested, an Initial Survey is to comprise sea trial or initial in-service testing, reporting and assessment against the criteria set out in these Rules.

6.1.2 The sea trial or initial in-service testing requirements are set out in Section 4, and are to be reported in accordance with Section 5 and evaluated against the requirements of Sections 2 and 3.

6.2 Maintenance of class notation through-life and following modifications

6.2.1 Where an Owner has requested assignment of a Class Notation, arrangements are to be agreed between LR and the Owner to record observations/complaints of excessive noise and vibration that have been such as to disturb the comfort of passengers and crew. The records of the observations are to be made available to the attending LR Surveyor at each Annual Survey.

6.2.2 Where the observations indicate that the noise and/or vibration levels may exceed the criteria relating to the Class Notation requirements and those measured at the Initial Survey, a measurement programme is to be agreed between the Owner and LR and measurements taken in accordance with these Rules.

6.2.3 A Renewal Survey may be required following modifications, alterations or repairs including replacement of major machinery items. It is the responsibility of the Owner to advise LR of such modifications.

■ *Section 7*
Referenced standards

7.1 Noise

7.1.1 The following National and International Standards for noise are referred to in these Rules:

- ISO 2923, *Acoustics – Measurement of noise on board vessels*.
- ISO 717/1, *Acoustics – Rating of sound insulation in buildings and of building elements; Part 1: Airborne sound insulation*.
- ISO 717/2, *Acoustics – Rating of sound insulation in buildings and of building elements; Part 2: Impact sound insulation*.
- IMO Resolution A.468(XII), *Code on noise levels on board ships*.
- IEC Publication 651, *Sound level meters*.
- ISO140/4, *Acoustics – Measurement of sound insulation in buildings and of building elements; Part 4: Field measurements of airborne sound insulation between rooms*.

- ISO 140/7, *Acoustics – Measurement of sound insulation in buildings and of building elements; Part 7: Field measurements of impact sound insulation of floors*.

7.2 Vibration

7.2.1 The following National and International Standards for vibration are referred to in these Rules:

- ISO 6954:1984, *Mechanical vibration and shock – Guidelines for the overall evaluation of vibration in merchant ships*.
- ISO 6954:2000, *Mechanical vibration and shock – Guidelines for the measurement, reporting and evaluation of vibration with regard to habitability on passenger and merchant ships*.
- ISO 8041, *Human response to vibration. Measuring instrumentation*.

Cross-references

Section numbering in brackets reflects any Section re-numbering necessitated by any of the Notices that update the current version of the Rules for Ships.

Part 3, Chapter 4

8.2.4.e Reference to Pt 3, Ch 9,12.2 *now reads* Pt 3, Ch 9,13.2.

Part 3, Chapter 5

5.1.4 Reference to Pt 3, Ch 9,12 *now reads* Pt 3, Ch 9,13.

Part 3, Chapter 6

4.1.5 Reference to Pt 3, Ch 9,12 *now reads* Pt 3, Ch 9,13.

5.1.3 Reference to Pt 3, Ch 9,12 *now reads* Pt 3, Ch 9,13.

Part 3, Chapter 9

12.1.3 *(13.1.3)* Reference 12.2.1 *now reads* 13.2.1

12.3.1 *(13.3.1)* Reference 12.2.1 *now reads* 13.2.1

12.4.1 *(13.4.1)* Reference 12.2.1 *now reads* 13.2.1

Part 4, Chapter 1

5.1.2 Reference to Pt 3, Ch 9,12 *now reads* Pt 3, Ch 9,13.

6.1.5 Reference to Pt 3, Ch 9,12 *now reads* Pt 3, Ch 9,13.

7.1.4 Reference to Pt 3, Ch 9,12 *now reads* Pt 3, Ch 9,13.

8.2.6 Reference to Pt 3, Ch 9,12 *now reads* Pt 3, Ch 9,13.

Part 4, Chapter 2

5.2.3 Reference to Pt 4, Ch 2,5.2.4 *now reads* Pt 4, Ch 2,5.2.6.

Part 4, Chapter 5

6.1.1 Reference to Pt 3, Ch 9,12 *now reads* Pt 3, Ch 9,13.

Part 4, Chapter 7

2.2.3 Reference to Pt 3, Ch 9,12 *now reads* Pt 3, Ch 9,13.

Table 7.8.1 Reference to Pt 3, Ch 9,12 *now reads* Pt 3, Ch 9,13.

9.2.2 Reference to Pt 3, Ch 9,12 *now reads* Pt 3, Ch 9,13.

Part 4, Chapter 9

9.3.8 Reference to Pt 3, Ch 9,12 *now reads* Pt 3, Ch 9,13.

Part 4, Chapter 10

1.1.2 Reference to Pt 3, Ch 9,12 *now reads* Pt 3, Ch 9,13.

Part 5, Chapter 2

13.5.1.a *(15.5.1.a)* Reference to Pt 6, Ch 1,2.11.2 *now reads* Pt 6, Ch 1,2.12.2.

13.5.1.b *(15.5.1.b)* References to Pt 6, Ch 1,2.12.4 and 2.12.5 *now read* Pt 6,Ch 1,2.13.4 and 2.13.5

13.5.1.c *(15.5.1.c)* References to Pt 6, Ch 1,2.9.3 and Pt 6, Ch 1,2.12.5 *now read* Pt 6, Ch 1,2.10.3 and Pt 6, Ch 1,2.13.5.

Part 5, Chapter 13

11.1.1 Reference to Pt 5, Ch 15,2.4.2 *now reads* Pt 5, Ch 15,2.4.4.

Part 5, Chapter 15

3.5.2 Reference to Pt 6, Ch 2,13.9.10 *now reads* Pt 6, Ch 2,13.9

Part 5, Chapter 23

8.1.6.a Reference to Pt 6, Ch 1,2.11 *now reads* Pt 6, Ch 2,2.12.

8.1.6.b Reference to Pt 6, Ch 1,2.11 *now reads* Pt 6, Ch 2,2.12.

8.1.7 Reference to Pt 6, Ch 1,2.12 *now reads* Pt 6, Ch 2,2.13.

Part 6, Chapter 1

1.2.5 Reference to 2.12.2 *now reads* 2.13.2.
Reference to 2.12.5 *now reads* 2.13.5.
Reference to 2.9.5 *now reads* 2.10.5.
Reference to 2.11.3 *now reads* 2.12.3.
Reference to 2.9.21 *now reads* 2.10.21.

1.3.2 Reference to 2.9.5 *now reads* 2.10.5.
Reference to 2.11.3 *now reads* 2.12.3.

2.2.7 Reference to 2.9 *now reads* 2.10.

2.8.8 Reference to 2.9 *now reads* 2.10.

2.9.1 References to 2.10, 2.11 and 2.12 *now reads*
(2.10.1) 2.11, 2.12 and 2.13.

2.9.2 References to 2.9 to 2.12 *now reads* 2.10 to
(2.10.2) 2.13.

2.9.5 Reference to 2.11.3 *now reads* 2.12.3.

2.9.6 Reference to 2.11.2 *now reads* 2.12.2.
(2.10.6) Reference to 2.11.8 *now reads* 2.12.8.

2.10.1 References to 2.10.2 to 2.10.10 *now reads*
(2.11.1) 2.11.2 to 2.11.10.

2.10.3 Reference to 2.11.2 *now reads* 2.12.2.
(2.11.3)

2.11.1 References to 2.11.2 to 2.11.10 *now reads*
(2.12.1) 2.12.2 to 2.12.10.

2.12.1 References to 2.12.2 to 2.12.7 *now reads*
(2.13.1) 2.13.2 to 2.13.7.

2.12.7 References to 2.9.19 to 2.9.20 *now reads*
(2.13.7) 2.10.19 to 2.10.20.

6.1.2 Reference to 2.12.5 *now reads* 2.13.5.

6.2.1 References to 2.9 to 2.12 *now reads* 2.10 to 2.13.

6.2.3 Reference to 2.11.7 *now reads* 2.12.7.

6.3.1 References to 2.9.19 to 2.9.20 *now reads* 2.10.10 to 2.10.20.

Part 6, Chapter 2

1.2.11 Reference to Pt 6, Ch 2,11.8 *now reads* Pt 6, Ch 2,11.7.

1.14.1 Reference to 16.5 *now reads* 16.6.

13.13.1 References Pt 6, Ch 2,13.13.3 and 13.13.6 *now read* Pt 6, Ch 2,13.13.4 and 13.13.7.

16.5.3 Reference to 16.5.2 *now reads* 16.6.2.
(16.6.3)

16.5.4 Reference to 16.5.2 *now reads* 16.6.2.
(16.6.4)

16.5.5 Reference to 16.5.2 *now reads* 16.6.2.
(16.6.5)

Part 6, Chapter 3

3.2.1 Reference to Pt 6, Ch 3,3.2.11 *now reads* Pt 6,Ch 3,3.2.9.

Part 7, Chapter 4

2.4.1 Reference to Pt 6, Ch 1,2.9 *now reads* Pt 6, Ch 2,2.10.

Part 7, Chapter 9

3.1.4 References to Pt 6, Ch 9,3.1.9, 3.1.10 and 3.1.11 *now read* Pt 6,Ch 3,3.1.10 to 3.1.12.

3.1.7 Reference to Pt 6, Ch 9,3.1.12 *now reads* Pt 6,Ch 3,3.1.13.

5.2.2 Reference to Pt 6, Ch 1,2.9, 2.10, 2.11 and 2.12 *now reads* Pt 6, Ch 2,2.10, 2.11, 2.12 and 2.13.

5.3.11 Reference to 3.1.9 *now reads* 3.1.10.

5.3.13 Reference to Pt 6, Ch 9,3.1.9 *now reads* Pt 6,Ch 3,3.1.10.

Part 7, Chapter 12

3.1.5 Reference to Pt 6, Ch 1,2.12.5 *now reads* Pt 6,Ch 1,2.13.5.

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